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Production control restraints and efficient use of agricultural resources

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PRODUCTION CONTROL RESTRAINTS AND EFFICIENT USE OF AGRICULTURAL RESOURCES

by

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INTRODUCTION

The existence of a problematic situation in American agriculture is widely recognized. It is generally agreed that low farm incomes are the primary cause for concern.

Agriculture's share in the gross national product has declined throughout the past half century. More crucially, however, in recent years net income of agriculture also has declined absolutely. During the most recent 10 year period, realized net income from agriculture has declined by about 20 percent (65, pp. 4-8). A marked decrease in the number of farms and an increase in non-farm earnings of farmers have prevented a decline in average per capita earnings of farm people. But incomes of non-farm persons have increased steadily in recent years. By most accepted measures, incomes of farmers are now low in comparison to incomes in the non-farm sector of the economy (6,45).

The disadvantageous income position of farmers has developed during a period of rapidly rising farm productivity. The contrast of rising productivity and falling incomes has produced among farmers a feeling of economic injustice and of need for remedial action. Efforts to improve farmers' incomes have centered on the support of farm product prices. As an outgrowth of price support efforts large stocks of farm commodities have accumulated in government storage. Production controls have not been restrictive enough to equate quantities supplied to quantities demanded at the supported prices.

A continuing reappraisal and reformulation of farm policies and programs is taking place. For some commodities, such as tobacco, production control programs have been developed that successfully support prices and producers' incomes without accumulating surpluses. For other commodities, such as wheat, feed grains, and livestock products, past programs have been less successful. A need still exists for developing improved policies and programs to be applied in agricultural sectors where income and surplus problems persist.

Purpose and Objectives

The over-all purpose of this study is to ascertain the effects of alternative methods of controlling production in the feed-livestock sector of agriculture. The investigation is limited to a program of direct control over the output of feed grain and soybeans.

The scope of this investigation is limited to partial equilibrium analyses of individual firms and of a small production area. The method will thus be to exemplify the effects of a particular form and level of production control operating within an assumed general equilibrium setting. The aggregate effects and general equilibrium setting of production control are derived from other analyses.

It is not the purpose of this study to decide upon a best method of controlling production. The consequences of alternative programs are presented. Selection of a best program must await synthesis of this study with analyses of alternative programs and other producing areas and indication by a policy making body of the relative values which society attaches to various goals (7, p. 13).

The specific objectives of this study are:

1. To estimate the effects of output control upon the production and resource use of typical Corn Belt farms.

2. To aggregate the results of individual firm analyses into an estimate of the effects of output control upon a specific Corn Belt production area.

3. To compare the economic effects of alternative methods of obtaining participation in an output control program.

ANALYTICAL SETTING

Statement of the Problem

The feed-livestock sector produces more than one-half of the total value output of American agriculture. The volume of output from the feed-livestock sector has increased steadily in the post-war period. Output has increased more rapidly than expanding population and rising incomes have increased consumer demand for livestock products. As a result, prices have fallen.

The impact of declining prices on feed-livestock farms is reflected in the U. S. Department of Agriculture's estimates of incomes on typical commercial farms (69). The averages of net production and net income indexes for selected feed-livestock farms are shown in Table 1. Data for the years 1945, 1950, 1955 and 1960 are presented to indicate the changes taking place. Production and net farm incomes were relatively stable from 1945 to 1950. In the last decade, however, production per farm has increased to 45 percent above the 1947-49 average. During the same period net farm incomes, measured in constant dollars, declined to about 25 percent below the 1947-49 average. The decline in net farm incomes thus has closely followed price depressing increases in output.

Table 1. Index of net production per farm and net farm income in constant dollars - average for selected feed-livestock farms[a] 1945, 1950, 1955 and 1960 (69)

Year	Average index of net farm production[b] (1947-49 = 100)	Average index of net farm income[c] (1947-49 = 100)
1945	100	98
1950	102	89
1955	116	55
1960	145	75

[a]Farms included in averages are: western Wisconsin dairy, Cornbelt hog-dairy, Cornbelt hog-beef raising, Cornbelt hog-beef fattening, Cornbelt cash grain, Northern Plains spring wheat-corn-livestock, and Intermountain cattle.

[b]Production valued at 1947-49 prices.

[c]Returns to capital and labor adjusted by the U.S. index of prices paid for family living items.

Income improvement efforts in the feed-livestock sector have been directed primarily toward supporting feed grain prices through the use of nonrecourse loans. As an intermediate product both produced and used within the feed-livestock sector, the price of feed grains does not directly influence sector income. The assumption has evidently been that support of feed grain prices would in turn improve the prices of livestock and livestock products.

There is evidence that feed grain prices do in fact influence livestock prices (57, pp. 272-274). Higher feed grain prices lead to decreased demand for feed grains as a factor in livestock production. The decreased consumption of feed grains by livestock is partially offset by use of other feeds but leads on balance to decreased livestock production. Finally, decreased livestock production leads to higher livestock prices.

Feed grain production control is needed if the system of supporting livestock prices through support of grain prices is to work without the accumulation of surpluses. Control programs have concentrated primarily upon corn which comprises about 70 percent of all feed grain production.

Acreage allotments were used, until 1959, in an attempt to reduce corn production and stop the build-up of surpluses. Compliance with allotments was made a necessary prerequisite to receiving price support loans except for years in which no initial carry-over was on hand. Noncompliance loans, at a lower rate, were made available to all producers in 1956, 1957, and 1958. Acreage allotments were not established for the 1959 and 1960 corn crops. In 1961, eligibility for price supports was again made contingent upon participation in an acreage reduction program.

Feed grain production control has also been attempted through programs offering direct compensation to producers who voluntarily withdraw resources from production. The acreage reserve of 1956-58, the conservation reserve of 1956-60, and the 1961 feed grain program each offered diversion payments for voluntary land retirement. Specific provisions of the programs have varied from year to year. The diversion payments usually have been 50 to 60 percent of gross crop value.

Despite these attempts to control feed grain output, surpluses have accumulated. Market prices for feed grains have been below support prices since 1948 with the exception of the Korean war years of 1950-52. Producers have delivered sizeable quantities of feed grain to the Commodity Credit Corporation in order to receive the price support. The Commodity Credit Corporation has only limited opportunities to resell these surplus stocks when market prices remain consistently below support prices. By the end of the October 1960 - September 1961 feeding year, feed grains owned by the Commodity Credit Corporation or held under price support loans are expected to total about 75 million tons or nearly one-half of 1951-1960 average annual production (70, p. 14).

Several alternative policies have been suggested as possible solutions to income and surplus problems in the feed-livestock sector. Expanding foreign or domestic demand for livestock products is one possible policy (16, pp. 151-153). Direct income grants in combination with free market prices is another (10, p. 649). Government assistance for resource adjustment is still another possible policy (31, pp. 171-172). This investigation is limited to a fourth major policy possibility--production control. This choice was made to narrow the field of inquiry. No judgment of other policies is intended.

Production Control Programs

Effective production control is one means by which the joint problems of low incomes and mounting grain surpluses may be solved for the feed-livestock sector of agriculture. The fact of price inelasticity of demand for products of the feed-livestock sector supports the inference that reduced marketings from a controlled output could be sold for more-than-proportionally increased prices. Gross and net revenues would be increased. If production controls were made sufficiently restrictive, higher producers' incomes could be attained without surplus accumulations. Alternatively, some rise in present prices and incomes might be foregone to permit disposition of surplus grain stocks.

Effective control of the output of agricultural products must come as a result of collective action. Each individual agricultural producer supplies a very small proportion of the total market. Any unilateral action which he might take to reduce output would have no discernable effect upon product prices. With a single market price prevailing for all producers, no individual producer can afford to reduce his own output except as a part of some collective action.

Collective action to reduce output may be initiated by producers' organizations or by the federal government. The particular agency which imposes the control may raise questions in the area of law, politics or administrative feasibility. For the purposes of this study, however, the agency imposing the controls is of no consequence. The study is couched in terms of governmental control. The results would be equally applicable to control by a private organization of producers.

Types of production control programs

There are many types of programs that might be utilized to implement a general policy of production control. Acreage allotments and land retirement programs were mentioned above as examples of production control programs that have been applied in the feed-livestock sector. Marketing quotas have been used for livestock products such as wool and fluid milk within a local marketing area and for crops outside of the feed-livestock sector, such as cotton and wheat. There are countless variations of specific provisions within each of these general types of programs.

Production control programs can be usefully classified on the basis of whether or not restraints are imposed directly upon the variable to be controlled. Indirect production control programs apply restraints on some resource used in production of the output to be controlled. Acreage allotments are an example of an indirect production control program. Under acreage allotments the amount of land that may be used to produce a particular product is restricted. The objective of the restriction is, of course, to control the output of the product. But, output of the product is dependent on other variables as well as on the quantity of land used. Quality of land, amount of capital inputs, and production methods are all important determinants of output. Compensating adjustments in the use of these other resources may cause the attained reduction in output to be considerably less than proportional to the reduction in acreage of land used.

A direct production control program, in contrast, imposes restrictions on the output of the product rather than on the use of a resource. Marketing quotas can provide direct control over the production of goods which pass directly from the producer into the marketing channels. When some of the product is not normally marketed, as is the case of feed grains, direct production control may only be obtained by the use of production permits.

Under direct production control producers have no opportunity to avoid part of the intended reduction by using additional or more productive resources or by adopting a superior production process. In this respect direct controls are more restrictive than indirect controls. However, under direct controls the possibility does exist to shift resources from production of the controlled product to the production of any uncontrolled product.

<u>Direct control in the feed-livestock sector</u>

Historically, most productions controls in the feed-livestock sector have been applied to feed grains. There are other quantities that might also be controlled. Soybean production might be controlled since soybeans provide a close substitute for corn in crop production and in livestock feeding. Forages also substitute for feed grains in crop production and in livestock feeding, and therefore might logically be controlled along with feed grains. Alternatively, direct control of livestock production has been suggested as a replacement for crop output controls (13, p. 700).

In this study the quantity to be controlled is the aggregate of all feed concentrates. On typical Corn Belt farms, the production of corn, oats, and soybeans all contribute to total feed concentrate production. For this study, the three crops were aggregated on the basis of

Jennings' estimates (30, p. 24) that the feeding value relative to corn of the three concentrate producing crops are:

corn = 1.00 per bushel

oats = 0.50 per bushel

soybeans = 1.65 per bushel.

<u>Aggregate and individual effects of production control</u>

Production control works through the effect of a reduced market supply to obtain higher prices than would result from unrestricted operation of the market. Higher prices serve as a means to a more ultimate objective of higher incomes to producers. If formulated and applied equitably not only will the total income to producers be increased but also incomes of most individual producers will be increased.

Output control applied to one product or a group of products will alter the composition of farm output away from the controlled product in favor of the uncontrolled products. The effect of output control upon individual producers will vary with the extent to which they are able to substitute output of other products for output of the controlled product. If an equal price rise is not obtained in all products, the effect of output control will also vary with the original composition of farms' total sales. Thus all farms will not benefit equally from production control.

Despite the expectation of increased incomes, individual producers will find it unprofitable to voluntarily reduce output. As a supplier of only a very small share of the market, the individual producer does not associate increased prices, which bring increased incomes, with changes in his own output. Therefore, either mandatory controls or some form of compensation are necessary to secure the participation of producers.

Effects of production control on other segments of the economy

Production control has an impact on the consuming and non-farm producing segments of the economy. Consumers must pay a price for food and other farm products that is higher than the free market price. Producers of items used in agricultural production will face an altered market situation due to constraints on farm output. Other producing sectors that are potential employers of resources now used in agriculture may find their factor supply increased if resources are released from agricultural production due to the effects of controls. Overall efficiency in the economy will be changed detrimentally if resources are retained in agriculture or in a particular phase of agriculture when their productivity would be greater in some alternative use.

This study is primarily concerned with effects of production control within agriculture and it is to that question that attention is directed. However, from time to time evidences of effects on other segments of the economy are noted.

DATA AND METHOD OF ANALYSIS

This study is a partial equilibrium analysis. It begins with an assumed general market position for agricultural products and proceeds to a detailed analysis of economic units which are components of the general system. The general market setting represents a market clearing position for agricultural products but it is not an equilibrium in the classical sense as pointed out by Hicks (28, pp. 110, 111). In the general market clearing position assumed here, supply is restricted arbitrarily and consequently prices are increased. The micro-analyses are based on market prices that are consistent with the general market clearing position. The micro-analyses thus exemplify economic units within a general market clearing position assuming output control.

General Market Setting of Production Control

The results of a macro-analysis by Paulsen and others (41) was taken as an estimate of a market clearing position in the feed-livestock economy.*

*The general assumptions of macro-analyses of Paulsen and others were: 1. Consumption of livestock products would depend primarily upon population and per capita income; 2. Feed grain utilization by livestock would continue at the high rate of 1958-60 if corn was at $1.00 per bushel but would decline if corn was at $1.30 per bushel; 3. Exports of feed grain would continue at about their present level with corn at $1.00 per bushel but would decline by about 4 million tons with corn at $1.30 per bushel; 4. Feed grain yields would follow the 1940-59 trend and use of fertilizer would continue to increase at the same rate as from 1953-59; 5. The current downtrend in oat acreage and uptrend in sorghum acreage would continue.

The model used by Paulsen considered all feed grains to be homogeneous as a factor in livestock production. Major livestock products were treated separately. Effect of price on quantity supplied and quantity demanded, and the interrelations between product markets were specified in the model. A constrained equilibrium in the market for livestock products was estimated from the model subject to the condition that a specified feed grain price be attained by reducing the output of feed grains.

The reduction in feed grain output that would achieve a market equilibrium was estimated to be 20 percent when the price of corn was specified at $1.30 per bushel and 10 percent when the price of corn was specified at $1.00 per bushel.

The estimated aggregate reduction of 20 percent in feed grain output and the associated product prices were taken as the aggregate setting for the micro-analyses of this study. A sufficient condition for consistency between the micro-analyses and the assumed macro-setting is that feed grain production be reduced by 20 percent on every farm or that the average of the reduction on all farms in the area studied be 20 percent. The necessary condition for agreement between the micro-analyses and the assumed macro-setting is that a deviation from a 20 percent reduction on any farm or in any area be counterbalanced by a deviation of equal amount and opposite direction on other farms or in other areas.

The Study Areas

Two study areas were chosen to represent a wide range of Corn Belt farming conditions. This analysis gives primary attention to the southern Corn Belt, hog and beef raising subregion which lies in south-central Iowa, northern Missouri, and part of east-central Illinois. An eight-county study area in southern Iowa was chosen to represent the subregion.

A central Corn Belt cash grain area was selected as a contrast to the hog-beef raising area. A seven-county northern Iowa study area was chosen from within the subregion which extends throughout central and north-central Iowa and southwestern Minnesota.

Data emanating specifically from the eight-county southern Iowa or seven-county northern Iowa study areas were used whenever possible. However, it was necessary to substitute some data which were available only for larger areas that contained one or the other of the study areas. Mention will be made in the text or in a footnote whenever a substitution of data is necessary. Statistics indicating the characteristics of the study areas are shown in Table 2.

Hereafter, the eight-county southern Iowa study area will be referred to as the southern Iowa area or simply as southern Iowa unless a more complete designation is required for clarity. Similarly, the seven-county northern Iowa study area will be referred to as the northern Iowa area or simply as northern Iowa.

<u>Southern Iowa</u>

The southern Iowa study area includes Union, Ringgold, Clarke, Decatur, Lucas, Monroe, Wayne and Appanoose counties. The study area is a part of Census Economic Subregion 71 (60).

Adjustment problems are more pronounced in southern Iowa than they are in most parts of the state (49). Average incomes are low. In 1959, annual returns to labor and capital were only $3417 on typical commercial farms in the hog-beef raising area (69, p. 28-29).

Consolidation of farms is proceeding rapidly in the southern Iowa area. The number of farms declined by 15 percent during the five year period 1954-59 (61). Farms in the 80 to 160-acre size range are being rapidly assimilated into larger holdings. But small part-time and residential farms remain quite numerous.

Thirty-five percent of the farms in the southern Iowa study area harvested less than 50 acres of crops in 1959. Twenty-nine percent had less than $2500 gross sales.

Thirty-five percent of the farm operators worked off their farms.

The southern Iowa area is in the Shelby-Grundy-Haig and the Shelby-Seymour-Edina soil areas. More than one-half of the cropland is on rolling to steep Shelby and Lindley soils (71). These soils are not highly productive. Prevention of serious soil erosion requires that a large proportion of the land be in hay and pasture. In 1959, hay accounted for 29 percent of the crops harvested. Total pasture acreage in 1959 was slightly greater than the acreage of cropland harvested. Three-fourths of the pasture was on non-cropland.

Forages made up 55 percent of the southern Iowa area's total feed production in 1959.* Livestock enterprises that use relatively large amounts of forages are quite common. Beef cow herds and farm flocks of sheep make up a larger proportion of total livestock production than they do in other parts of the state. Few feeder cattle are brought into the area to be fattened. More commonly, beef calves or feeder pigs that were raised in the area are sold before reaching market finish to farmers in areas having more abundant supplies of grain.

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*Based on U.S. Census of Agriculture (61) and the assumption that one ton of hay or one acre of pasture is equivalent in feed value to 15 bushels of corn or corn equivalents of other grains.

Northern Iowa

Farm incomes are higher in the northern Iowa area. The U. S. Department of Agriculture estimated that 1959 returns to labor and capital averaged $5698 on Corn Belt cash grain farms (69, pp. 32-33).*

Some consolidation of farms is taking place in the northern Iowa area. There was a 7 percent decline in farm numbers during the period 1954 to 1959 (61). There are few part-time or residential farms. The most common farm size is 160 acres; farms with 240 acres, 320 acres or more are becoming more numerous.

The northern Iowa area is located in the Clarion-Webster soil association. The predominating Clarion, Webster and Nicollett soils are productive and mostly free from erosion hazards. Much of the area is agronomically capable of producing continuous row crops. In 1959, row crops were harvested from 68 percent of the cropland. Only 14 percent of the land was used to raise hay and pasture.

Grains made up 87 percent of total feed output in 1959.* Cattle and hog fattening enterprises dominate livestock production. Many farms classified as cash-grain farms have fairly sizeable hog and cattle feeding enterprises in addition to their cash-grain operations.

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*The area covered by this average included a central Illinois subregion as well as the northern Iowa-southern Minnesota subregion.

Table 2. Selected statistics of the southern Iowa and northern Iowa study areas (69, pp. 29,33; 61)

Item	Units	Southern area	Northern area
Net income per farm, 1959	$	3417	5708
Farms with more than $2500 sales	%	71.2	93.0
Decline in number of farms 1954-59	%	15	5
Average farm size	acres	223	210
Farms with less than 50 acres of cropland harvested	%	35.0	9.6
Farm operators working off their farms	%	34.6	25.2
Farm operators working off their farms 100 days or more		17.8	7.1
Land in farms by use			
Cropland	%	58.0	88.0
Open pasture	"	25.9	5.3
Woodland pasture	"	7.9	0.7
Waste, lots, etc.	"	8.2	6.0
Cropland by crops planted			
Corn	%	37.1	52.3
Soybeans	"	9.9	15.8
Oats	"	9.9	16.0
Hay	"	23.0	8.9
Pasture	"	19.1	5.5
Other	"	1.0	1.5
Bushels of feed grain per ton of hay	bu.	34	168
Bushels of feed grain per acre of pasture	bu.	20	280
Proportion of forage in total feed output	%	55.0	13.0
Number of livestock per farm			
Beef cows	number	12	4
Milk cows	"	4	4
Ewes	"	9	6
Pigs born	"	53	73
Cattle sold	"	8	21
Calves sold	"	9	3

Describing the Population of Farms

Each farm in an area differs in some respect from every other farm. An exhaustive analysis of farms within an area would require that each farm be treated separately on the basis of its unique characteristics. However, research capacities limit the number of specific farm situations that can be subjected to analysis. It is necessary, therefore, to analyze representative farms that are similar to groups of farms rather than identical to any particular farm (58, pp. 32-33).

The first step in selecting representative farms for analysis in this study was to stratify the population of farms in terms of characteristics which were expected to affect response to grain production control. A survey of a random sample of farms in each of the study areas was the primary source of data for stratifying the population of farms. (See Appendix A for a description of the survey.) Additional information was drawn from the 1959 U.S. Census of Agriculture (61) and the Soil Conservation Service's Conservation Needs Inventory (71).

Detailed descriptions of the procedures used to stratify the population of farms in each area are given in Appendix A. The estimated distribution of farms is given in terms of relative frequencies (proportions) in Table 25.

Southern Iowa

The population of southern Iowa farms was stratified on the basis of four characteristics--farm size, topography, labor supply, and capital supply. Farms were divided into three strata within each of the four characteristics. For example, all farms were classified by size as either small, medium or large. Definitions of strata and distributions of farms by strata are shown in Table 3.

Table 3. Definition of strata and percentage distribution of southern Iowa farms by strata within each of four characteristics

Characteristic and stratum	Item and unit	Range within strata	Percent of farms
Farm size			
Small	acres of farmland	30-179	44.0
Medium	" "	180-299	31.0
Large	" "	300 and above	25.0
Topography			
Rough	corn yield index	0-14.9	36.4
Average	" "	15.0-29.9	54.7
Level	" "	30.0 and above	8.9
Labor supply			
Part-time	man hours	0-2499	10.1
One-man	"	2500-3499	70.1
Two-man	"	3500 and above	19.8
Capital supply			
Cash-grain	feed fed/feed produced	0-0.5	35.0
Intermediate	" "	0.5-1.0	42.5
Unlimited	" "	1.0 and above	22.5

Each stratum was further subdivided according to other characteristics. For example the stratum of small farms was subdivided on the basis of topography into small rough farms, small average farms, and small level farms. Further subdivisions within strata were made until all four characteristics were taken into account.

The term substratum is reserved to refer to a unique combination of values of the four characteristics. For example, the substratum chosen as a bench mark farm, consists of farms that are classified in the intermediate strata of each of the four characteristics. A representative farm for this substratum is medium sized (240 acres) with land of average topography, a one-man supply of labor and an intermediate supply of capital.

The total number of substrata is given by the product of the number of strata within each farm characteristic. In southern Iowa there were (3)(3)(3)(3) = 81 substrata.

<u>Northern Iowa</u>

The population of farms in northern Iowa was not so finely subdivided as was the population of southern Iowa farms. There is less variation in the characteristics of northern Iowa farms making it possible to adequately represent the population of farms with fewer substrata. Also, analysis of this area was primarily for the purpose of providing comparisons and therefore was not carried out in as great detail.

Three characteristics--farm size, labor supply, and capital supply--were used to describe the population of farms in the northern Iowa area. The population of farms was divided into two strata within each characteristic. The total number of substrata was (2)(2)(2) = 8.

Table 4. Definition of strata and percentage distribution of northern Iowa farms by strata within each of three characteristics

Characteristic and stratum	Item and unit	Range within strata	Percent of farms
Farm size			
Small	acres of farmland	30-239	52.2
Large	" "	240 and above	47.8
Labor supply			
One-man	man hours	less than 3499	78
Two-man	"	3500 and above	22
Capital supply			
Cash-grain	feed fed/feed produced	0-0.5	65
Unlimited	" "	0.5 and above	35

Developing a Linear Programming Farm Model

A linear programming model was constructed to depict a representative farm from each substratum within the study areas. The linear programming model is a mathematical abstraction often used to synthesize the production planning environment of individual farm firms (24, pp. 194-231). As an abstraction, the model is subject to certain assumptions which may not agree fully with the real world setting in which farmers make decisions.

Assumptions of the model

The assumptions of the linear programming model are: 1. Individual production processes yield constant returns to scale and are completely divisible; 2. Production processes are additive; 3. Expectations of resource requirements, yields and prices are single-valued (24, pp. 17-18); 4. A linear objective function is maximized or minimized subject to linear inequalities (24, pp. 7-8). Various procedures have been developed for solving linear programming problems in which one or more of these assumptions have been relaxed (24, pp. 232, 265, 528, 554).

In the linear programming model formulated for this study net returns above operating expenses were assumed to be the objective function to be maximized. An intermediate length of planning period is implied by permitting free adjustment of crop and livestock enterprises but no change in resource supplies. To make the problem computationally feasible, the model is constructed to include only a limited number of resource restraints and production processes.

Resource restrictions

In a linear programming model, resource restrictions define the production possibility frontier by limiting the maximum level of a production process or set of production processes. For this study, resource restrictions were set equal to the mean of available resource supplies on farms within the various strata (see Tables 27 and 28 for a list of resource supplies by strata).

Land The total acreage of land in the representative farm situations was taken to be equal to the mean acreage on farms within the particular size strata as reported in the 1959 Census of Agriculture.

In southern Iowa, cropland was assigned to one of three productivity classes on the basis of slope. The land classes were defined as:

Class I - 0 to 1 percent slope
Class II - 2 to 5 percent slope
Class III - 6 to 12 percent slope.

The distribution of land by productivity classes and by other uses was taken from the average distribution on tracts of land within each topography strata. The tracts of land used for this purpose were those surveyed in connection with the national Conservation Needs Inventory (71). A description of the Conservation Needs Inventory and the method of stratifying the sample of tracts by topography is given in Appendix A.

Cropland estimated from the survey tracts of land exceeded the total as reported in the 1959 Census of

Agriculture by an amount equal to 7 percent of all land in farms. The total amount of cropland and the amount assigned to each class of land was adjusted downward to bring conformity with the amount reported in Census.

In northern Iowa farms were not stratified by topography or productivity of land. All land was assumed to be homogeneous with respect to crop yields and fertilizer requirements. However, 60 percent of the cropland that has a slope of less than 3 percent was assumed to be adaptable to continuous row cropping while the remaining 40 percent was assumed to require at least one year of meadow in every five years of cropping.

Labor The annual supply of labor available on farms was taken from the mean of each of the labor strata. Hired and family labor was tabulated as reported on survey farms. Each hour of family labor was assumed to be equivalent to 0.75 man hours. Farm operators were assumed to work a total of 48 hours per week at farm and non-farm work.

The seasonal distribution of labor on the part-time farm is based on the assumption of 83 hours of labor available per month plus a total of 17 hours overuse available if balanced by underuse during another season. The one-man labor supply is distributed seasonally on the basis of 55 hours of operator, family, and hired labor available throughout the year plus an additional 25 hours of labor per week available during the summer months of June and July. The two-man labor supply includes the same amounts available in the one-man supply plus an additional 150 hours of hired labor in each month.

Capital The supply of capital available was limited in the cash grain and intermediate capital farming situations. The maximum amount that could be used for production expenses and livestock inventories was assumed to equal requirements for crop expenses (see Tables 29 to 31) plus sufficient capital for a specified livestock program (see Tables 32 to 35 for capital requirements per head). For the cash grain farms the specified livestock program was 5 litters of hogs and 5 dairy cows. For the intermediate capital farms the livestock program was determined by the maximum number of hogs and beef cows that could be fed from the crop production of the farm.

Farming situations designated as "unlimited capital" were limited in capital use only by the requirement that marginal returns to capital be greater than marginal costs of $0.06 per dollar used.

Production processes or enterprises

Each linear programming production process corresponds to a farm enterprise operated with a single set of production techniques. A different production process must be used to represent different techniques of producing the same enterprise. In this study, production processes included in programming models correspond to enterprises and production techniques commonly employed on farms in the study areas. Special, but relatively uncommon, enterprises or techniques such as wheat production or fluid milk production were not included. All production processes used in this study were developed to represent rates of efficiency attained by Iowa farmers with average management skills.

<u>Crop production processes</u> Crop production processes were formed as rotations of corn, oats, soybeans and meadow. A complete listing of yields and production requirements is given in Table 29 and Table 30.

Crop processes for each land class ranged from the most intensive rotation possible within the limits of a maximum annual soil loss of 10 tons per acre to a continuous meadow with renovation every sixth or eighth year.

Crop rotations permitted on each class of land are listed in Table 5. The alphabetic designation of crops are:

Corn	C
Soybeans -	Sb
Oats	O
Meadow	M

Crop yields are consistent with average yields actually attained by Iowa farm operators. Fertilization was assumed to be at one of the following rates: 1. No fertilizer applied; 2. An intermediate application of fertilizer at 40 percent of optimum rate; or 3. Fertilizer applied at the economic optimum rate. Fertilization was limited to the intermediate

Table 5. Crop rotations included as possible production processes by class of land in southern and northern Iowa

Southern Iowa soils			Northern Iowa soils	
Class I	Class II	Class III	Class I	Class II
CCSb	C56COM		C	CSbCOM
CSbSb	CSbSbOM	CCOMMM	CCSb	CCOM
CCOM	CCOM	COMM	CSbSb	CCOMM
COM	CCOMM	COMMMM	CSbCOM	OMMMM
M	M	M	CCOM	
			CCOMM	
			OMMMM	

rate on southern Iowa farms. On northern Iowa farms, fertilization was limited to the intermediate rate in combination with no more than 50 percent of the land at the optimum rate.

Crop production costs include seed and spray costs at average rates of application, operating costs and repairs on machinery, and expenditures for commercial fertilizer. Machinery costs were developed for a two-row, three-plow set of machinery as the typical situation on southern Iowa farms. Part-time farms were assumed to employ custom harvesters rather than own harvesting equipment. In northern Iowa the large 330-acre farms were assumed to have four-row, four-plow machinery.

Livestock production processes The following alternative livestock processes were included in the linear programming models:

1. Hogs farrowed in early summer and raised on pasture.

2. Hogs farrowed twice yearly in a ratio of 2 spring litters to one fall litter.

3. Beef calves purchased and deferred fed on pasture for final sale as fat steers after 90 days finishing.

4. Yearling steers roughed through winter and full fed on pasture for fall marketing as finished cattle.

5. Yearling steers short-fed in dry lot for market finish six months after purchase (northern Iowa only).

6. A beef cow enterprise from which 450-pound calves are sold.

7. A beef cow enterprise with calves grain fed and sold as 1000-pound steers and heifers.

8. A low-productivity dairy enterprise from which cream is sold.

Input-output coefficients used to represent these enterprises reflect an average level of efficiency using typical production practices. Resource requirements, costs and returns for the livestock enterprises used in this study are listed in Tables 32, 33, 34 and 35, which are in Appendix B below.

Production costs for livestock production processes include only items that vary in total with the scale of the enterprise such as veterinary fees, electricity, personal property taxes, etc. The assumption of linearity requires that unit costs be unchanged with the size of enterprise. Fixed costs such as depreciation and general upkeep on buildings and fences are not included. No charge is made for use of feed, labor, and capital supplied from the resources available or produced on the farm. Feed requirements include an allowance for replacement stock and breeding males.

The accounting period for all enterprises is one year except in the case of cattle feeding enterprises which cover the period of time from purchase of feeder stock to sale of finished stock. Capital requirements for the enterprises are equal to the maximum amount of funds required for investment in livestock and equipment and for operating expenses during the accounting period. For enterprises such as dairy cows and hogs with more than one farrowing during the year some operating expenses in the latter part of the year may be met by receipts from products produced and sold early in the year. For this type of enterprise, capital requirements do not include total operating costs.

Special restrictions were placed on two of the livestock enterprises. First, the dairy enterprise was limited to no more than five cows to approximate its limits of expansion without requiring additional facilities and more attention. Second, existing hog facilities on livestock farms are assumed to be adequate for 15 litters in the southern Iowa area and 25 litters in the northern area.

Further expansion of the hog enterprise is possible only by an additional investment of $20 per litter for housing and fencing. Expansion beyond the present facilities for hog enterprises was assumed to result in a decline in output per litter and in reduced feeding efficiency as management problems, particularly disease control problems, become more serious.

Estimation of prices and net revenues

Enterprise net revenues comprise the objective function for a profit maximizing linear programming model. Operating costs and physical quantities of output which are required in calculating net revenues were obtained directly from input-output coefficients of each enterprise.

Three different projections of product prices were used to compute alternative estimates of net revenues. A set of high prices which presumes a 20 percent reduction in total feed grain output was taken from a study by Paulsen and others (39). These prices were developed from the aggregate model discussed on pages 14-16 above. A second set of prices was obtained by projecting 1961 prices under the assumption of production control and price supports continued at the 1959-1960 level. A set of free market prices were projected by Shepherd and others (51) as estimates of market clearing equilibrium prices with uncontrolled output. United States average prices for major farm products are shown in Table 6 under each of the three projections.

National average prices received for general products such as "hogs" were translated into prices for a specific grade and weight of product at a specific date and location. Simple regressions relating yearly average prices for specific products at terminal markets to national average prices of general products were estimated for the period 1950-59. (All b values were significantly different from zero at the 99 percent level of significance.) The regression equations were used to estimate terminal market prices for specific products from the projected national average prices. Estimated prices for specific products were adjusted for seasonality on the basis of average 1950-59 monthly price relatives at the terminal market. Average transportation costs from central Iowa and average selling costs were used to adjust all specific product prices to reflect prices received or paid by Iowa farmers.

The high prices were used to compute profit maximizing farm plans. Profit maximizing plans were not computed under the intermediate and low price assumptions. Some inferences as to the effect of price level on income are made using the intermediate and low prices in combination with optimum plans derived under the high price assumptions. An explanation of procedures and assumptions used in estimating prices and net revenues are given in Appendix

Table 6. Projected U.S. average prices for selected farm products at three different levels

Product	Unit	Projected prices		
		High[a]	1961[b]	Free market[c]
Corn	bu.	$1.30	$1.00	$0.66
Cattle	cwt.	20.00	17.00	12.00
Hogs	cwt.	16.50	13.00	11.00
Milk	cwt.	4.10	3.90	2.67

[a]Projected mid-1960 prices presuming 20 percent reduction from potential feed grain production (39).

[b]Forecasted 1961 prices under the assumption of continuation of 1959-60 government programs.

[c]Projected 1963 prices under a free market system (53, p. 17).

The fixed costs associated with ownership of the land, buildings and machinery do not change with the production plan followed. Therefore they do not enter into the determination of enterprise net revenues. Fixed costs do, however, affect long run costs and returns to the operator's labor and entrepreneurial efforts. The procedures and data used in calculating fixed costs are given in Appendix A.

Introducing production control in linear programming models

Production control was introduced into the linear programming models of representative farms by making a production right or quota one of the resources required for crop production. Each crop rotation was assessed a production quota requirement equivalent to the units of feed concentrates produced by the rotation. Total production of feed concentrates was not permitted to exceed the total amount of quota available.

A parametric variable-price programming procedure (24, pp. 265-307) was used to evaluate response to production control of varying restrictiveness. An initial endowment of production right or quota was provided in the programming model of each representative farm. The initial endowment was made sufficiently large to preclude its becoming a limitation upon the profit maximizing production plan of the farm. A quota selling activity was then introduced into the programming model. Initially all quota which is surplus to that required for the profit maximizing plan is "sold" at a price of zero. The price of the quota selling activity is then systematically increased. As the price of quota is increased it becomes profitable to "sell" additional units of quota. Feed concentrate production is reduced as fewer units of quota remain available for use by crop rotations. Eventually a price is reached at which all quota is sold and the production of feed concentrates completely excluded from the production plan.

The formulation of the model corresponds to a program in which quotas are assigned and then made negotiable or to a program in which the government bids for farmers' participation in production control. Other interpretations of the model are possible. Mandatory production restraints will result in the same production plan as quota sales. The results under mandatory restraints differ from the comparable quota selling situation only by a net revenue reduction equal to the sale value of the quota.

Selecting Representative Farms to be Analyzed

Each of the substrata has a corresponding representative farm situation which might be analyzed to determine response to production control measures. However, it may be possible to obtain a reasonably accurate estimate of response to production control without analyzing all farm situations. Representative farm situations from substrata which contain only an insignificant portion of the total population of farms were excluded from the analysis. Response of farms in these substrata is of little or no consequence to the total response of the area. On the basis of the relative frequencies shown in Table 25, 43 southern Iowa farm situations that represent a substratum having less than one-half of one percent (.005) of the total number of farms in the area were not analyzed.

Other representative farm situations may not need to be analyzed because of the similarity of their response and the response of some other representative farm situation. In the extreme case the responses of two representative farms may be related exactly by a known linear function.

Only one of the two linearly related farm situations need be analyzed as the response of the other may be estimated directly from the results of the analysis of the first. In actual practice, something less than an exact known linear relation may be acceptable.

The following procedure was used to select representative farm situations for analysis from among the 38 southern Iowa substrata which each have more than one-half of one percent of the population of farms:

1. A bench-mark farm situation was analyzed. This bench-mark farm corresponds roughly to the median type of farm. All resources are at an intermediate level. Specifically it represents a farm with 240-acres of average land, a one-man labor supply, and an intermediate capital supply.

2. Representative farms that differ from the bench-mark farm in only one important characteristic were analyzed. There were eight such representative farms. Before analyzing each successive farm the results of preceding analyses were reviewed. Where previous results indicated that little new information would be obtained certain farms in this group were omitted. For example the bench-mark farm situation, which has a one-man labor supply, was not limited by labor during any season of the year. Additional labor would be redundant; therefore, it was not necessary to analyze a two-man farm with the same land and

capital resources. Six farms from among the eight in this category were analyzed. They were farms 2, 3, 4, 6, 9 and 10 in Table 7.

3. Selected representative farms that differ from the bench-mark farm in more than one characteristic were analyzed. There were 29 possible choices of farm situations representing substrata with relative frequencies of more than one-half of one percent. Both relative frequency of the substrata and potential new information that could be obtained from the analysis were taken into consideration. Six representative farms were chosen by judgment. They were farms 5, 7, 8, 11, 12 and 13 in Table 7.

Two special southern Iowa farm situations were analyzed to provide information as to the importance of cattle feeding as an enterprise on farms with a controlled grain output. Beef feeding was excluded from production processes on the special farm situations. Both of the special farm situations are medium-sized, rough, one-man farms. One has an intermediate supply of capital and one an unlimited supply. The special situations are exactly the same as situations 10 and 12 in Table 5 with the exception of the exclusion of beef feeding enterprises.

Four northern Iowa representative farm situations were analyzed. They represent farms of 160 and 330 acres with very limited (cash grain) and with unlimited capital

Table 7. Representative farm situations that were chosen for analysis as defined by the characteristics of the substrata which they represent

Area and farm situation number	Characteristics of			
	Farm size	Topography	Labor supply	Capital supply
Southern Iowa				
1	240 A.	average	one-man	interm.
2	240 A.	average	one-man	unlim.
3	240 A.	average	one-man	cash grain
4	240 A.	average	part-time	interm.
5	480 A.	average	two-man	unlim.
6	480 A.	average	one-man	interm.
7	110 A.	average	part-time	interm.
8	240 A.	level	one-man	cash grain
9	240 A.	level	one-man	interm.
10	240 A.	rough	one-man	interm.
11	480 A.	rough	one-man	interm.
12	240 A.	rough	one-man	unlim.
13	480 A.	rough	one-man	unlim.
14 (special)[a]	240 A.	rough	one-man	interm.
15 (special)[a]	240 A.	rough	one-man	unlim.
Northern Iowa				
16	160 A.	average	one-man	cash grain
17	160 A.	average	one-man	unlim.
18	330 A.	average	one-man	cash grain
19	330 A.	average	one-man	unlim.

[a]Special farm situations do not have beef cattle feeding included as an alternative production process.

supplies. No northern Iowa situations were analyzed that correspond to the intermediate capital situations in southern Iowa. This change was made because previous research studies have shown that capital rationing does not appear to be serious on farms in this area (23, 1075).

Forming an Aggregated Area Model for Southern Iowa

A model of the southern Iowa study area was constructed by linear aggregation of results from individual farm analyses. Aggregation was not attempted for northern Iowa.

The number of farms occurring in the substratum that corresponds to the representative farm situation was assigned as a weighting factor aggregation. Substrata for which no representative farm was analyzed were brought into the aggregation process by adding their assigned weight to that of a representative farm situation which was hypothesized to have approximately the same response to output control. When the size of the farm which was being approximated differed from the size of the representative farm situation a scale adjustment of the representative farm situation was carried out prior to aggregation.

The contribution of the j^{th} representative farm situation to aggregate output is given by

$$\sum_{j=1}^{1} \sum_{i=1}^{n} a_i b_i x_j$$

where a_i = number of farms in the i^{th} substratum that are being represented or approximated by the j^{th} representative farm situation

b_i = ratio of acres of land per farm in the i^{th} substratum to acres of land per farm in the j^{th} substratum.

x_j = value in the j^{th} representative farm situation of the variable being aggregated.

Table 26 gives the relative frequencies of the analyzed and approximated farm situations and the weights used for aggregation.

PROFIT MAXIMIZING FARM PLANS WITH NO CONTROLS ON OUTPUT

Profit maximizing farm plans with no control on output provide the norm against which profit maximizing plans with a reduction in feed concentrate output are compared to gauge the effects of production control. Profit maximizing farm plans with no controls are discussed briefly in this chapter to provide the setting from which adjustments to production control are being made.

The profit maximizing farm plans with no controls on output were derived from linear programming analyses with objective functions based on the high assumed prices. The projected 1961 prices would have been the correct ones to use to provide a comparison of the present situation to that of production control and increased prices. Therefore, when used as a norm to indicate the effects of production control, price changes following from the aggregate effects of output reductions are not taken into account. However, quantities of the profit maximizing plan based on the high prices were assumed to be an approximation to the profit maximizing plan based on projected 1961 prices. Where an estimate of net revenue with 1961 prices was required, it was obtained by valuing the profit maximizing plan (high prices) at the 1961 prices. The basis for this assumption lies in the fact that when all prices move together incomes change but the combination of enterprises does not. The high assumed prices and projected 1961 prices approximately satisfy this condition.

The presentation of profit maximizing farm plans with no controls on output is centered in the bench-mark farm situation. Other plans are covered briefly in respect to the deviations of their profit maximizing plan from that of the bench-mark situation. The plans are discussed in groups selected to illustrate differences in profit maximizing farm plans that follow from differences in the initial allocation of important resources.

Bench-mark Farm--A Typical Southern Iowa Farm

The bench-mark farm represents a typical southern Iowa farm. Its land, labor and capital resources are taken from the intermediate stratum in each characteristic. Specifically, it is a 240-acre, average topography, one-man, intermediate capital southern Iowa farm. The profit maximizing plan for the bench-mark farm is given in Table 8.

In the profit maximizing plan for the bench-mark farm with no controls over output 62 acres of corn, 17 acres of soybeans, 27 acres of oats, and 55 acres of hay and meadow are raised. Feed grain production is 3080 bushels of corn equivalents. Three-hundred and seventy bushels of soybeans (610 feed units) and 86 tons of hay are produced. Most of the corn and all of the soybeans are produced on class I and class II soils. A corn-corn-soybeans rotation is most

Table 8. Profit maximizing farm plan, costs and returns, and imputed resource productivities for the bench-mark farming situation with an uncontrolled output

Item	Unit	Value with no controls
Crop acreages		
Corn	acres	62.4
Soybeans	acres	16.8
Oats	acres	26.5
Meadow	acres	55.3
Crop production		
Feed grain	bu.	3080
Soybeans	bu.	370
Hay and meadow	tons	86
Permanent pasture	tons	41
Livestock		
Hogs	litters	21
Fat cattle	head	12
Beef cows	head	0
Dairy cows	head	5
Feed fed		
Feed grain	bu.	3080
Protein supplement	cwt.	156
Hay and pasture	tons	83
Costs and returns		
Net output	$	7904
Variable costs	$	1663
Net farm income	$	6241
Fixed costs	$	4727
Labor-mgt. returns	$	1514
Avg. return/hr. worked	$/hr.	0.68
Imputed marginal productivities		
Class I cropland	$/acre	40.48
Class II cropland	$/acre	30.80
Class III cropland	$/acre	8.86
Permanent pasture	$/acre	0
All land	$/acre	13.61
Hay	$/ton	0
Labor (seasonal)	$/hr.	0
Labor (annual)	$/hr.	0
Capital	$/$ invested	0.44
Quota	$/feed unit	0.00

profitable for the 14 acres of class I land and a corn-soybeans-corn-oats-meadow rotation for the 60 acres of class II land. A corn-corn-oats-meadow-meadow-meadow rotation on 87 acres of class III land produces 60 percent of the hay and rotation meadow and about one half of the oats. All crops are fertilized at the highest permitted rate which is 40 percent of the optimum fertilization rate.

Average yields for the entire farm are 45 bushels per acre of corn, 30 bushels per acre of oats, 22 bushels per acre of soybeans and 1.6 tons per acre of hay.

Livestock production in the uncontrolled plan for the bench-mark farm includes 21 litters of hogs, 12 pasture-fed steers, and 5 dairy cows. All feed grain raised on the farm is fed on the farm and no grain is purchased for feeding. All hay and rotation pasture are used by the livestock, but 70 acres of permanent pasture and timber pasture, producing annually forage equivalent in feeding value to 41 tons of hay, are largely unused.

It is not uncommon to find unused or underutilized permanent pastures in southern Iowa. However, when capital is available, most farms have a beef cow herd to utilize the roughage from permanent pasture. It would be unusual for a farm in the southern Iowa area to have steer-feeding, hog and dairy enterprises of the size shown in the optimum plan without having a beef cow herd. However, on the basis of input-output coefficients and costs assumed in this study a change from steers to beef cows would reduce income about $18 per steer replaced. Consideration of uncertainty*, personal preference or a more restricted labor supply are all possible explanations for the deviation of actual practice from the indicated profit maximizing combination of enterprises.

Net farm output in the uncontrolled profit-maximizing plan is $7,900. Almost two-thirds of the value output comes from $5,000 worth of pork produced. The value of beef produced, over and above feeder stock purchased, amounts to $2,180 from 12 steers and cull dairy stock. Milk worth $780 and $900 worth of soybeans make up the remainder of total output. Purchases of feed and seed amounting to $950 are subtracted from total output to arrive at net value.

Returns to land, labor and capital at the uncontrolled output are $6,240. Fixed costs of taxes, insurance, general upkeep of property and interest on investment are $4,726. Residual labor-management returns are $1,514. The residual earning rate of labor is only $0.68 per hour on the basis of 2,200 hours of labor used. Five hundred hours of labor are available but unused in the profit maximizing plan.

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*The coefficient of variation for returns in livestock production has been estimated to be 21.49 for a beef cow, 25.28 for hogs and from 27.70 to 37.41 for cattle feeding in Brown and Heady (11, p. 552).

If computed on the basis of labor available rather than labor used, residual labor earnings are $0.56 per hour.

Imputed value productivities for resources are shown in Table 8. The imputed annual returns per acre of class I and class II cropland are $40.48 and $30.80 respectively. However, this land must ordinarily be purchased in combination with lower quality cropland, permanent pasture and waste land. The imputed annual return to land consisting of various soils in combination as they occur in the original allocation of land to this farm is $13.61 per acre.

An annual return of $13.61 per acre is approximately 30 percent higher than the average annual cost of $9.41 for interest and taxes on land, based on 1959 average land values and a 6 percent interest rate. Part of the difference between imputed returns and annual cost of land can be attributed to the use of assumed product prices that are higher than present prices in computing enterprise net revenues for the linear programming model. The high assumed prices range from 5 percent above the 1961 price for milk to 30 percent above the 1961 price for corn. The high prices give a value of output with uncontrolled production that is $1,100 higher than the value of the same products at 1961 prices. An 18 percent gain in net revenue is thus realized. A change to lower assumed prices in line with 1961 projected prices would have little effect upon the optimum organization of production. A change to lower prices would reduce net revenue by 18 percent and reduce imputed value productivities by about the same proportion. An 18 percent reduction would reduce the imputed annual value of land to $11.16 per acre which is closer to equality with annual costs.

The marginal value productivity of capital used for annual expenditures or for investment in livestock is $0.44 per dollar per year. This internal earning rate is considerably above the interest rate of about $0.06 per dollar per year on borrowed capital. It is not, however, at variance with earlier survey findings of an internal marginal productivity of capital that is much greater than the interest rate (22, p. 603-604).

Other Southern Iowa Farming Situations

Southern Iowa farming situations that vary from the bench-mark situation are discussed in pairs or larger groupings that illustrate the differences in profit maximizing farm plans that result from differences in farms' supplies of basic resources. Tables 37 to 54 in Appendix B give profit maximizing plans for these farming situations.

Differences in capital supply

Two southern Iowa farming situations, each differing from the bench-mark farm only in capital supply, were analyzed. Each of these farms was allocated 240 acres of average land and a one-man (2700 hours) labor supply.

Cash grain farm   The profit maximizing farm plan for a cash grain farming situation (Table 38) involves no changes in crop production from the plan for the bench-mark farm situation. The severely limited capital supply ($2,600 of operating and livestock investment capital) restricts livestock production to 8 beef steers in addition to the maximum permissible 5 litters of hogs.

Because of the limited livestock program, only one third of the feed grain and less than one fifth of the forage produced on the farm is fed to livestock on the farm. Surplus feed grain is sold at the market price of $1.25 per bushel. The option of selling hay and pasture was not permitted in the profit making alternatives; therefore, forages are grossly underutilized. Forages are produced on cropland only because of the need for soil conserving crops in rotation with grain crops.

Net farm output is $5,510, 30 percent below output in the bench-mark farming situation. Returns after variable costs are less than total fixed costs. As a result, annual labor-management returns are a negative $188. Adding the opportunity to sell surplus forage standing in the field at $8 per ton would increase labor-management returns by only $658 to a positive $470.

The imputed marginal value productivities of land and capital are almost identical to those of the bench-mark farm situation. A primary deterrent to adequate farm income is the nonuse of 1600 hours of operator and family labor. This surplus labor has no profitable employment on the farm due to the small, capital-limited livestock enterprises.

Unlimited capital farm The optimum cropping program for a 240-acre southern Iowa farm with an unlimited capital supply differs from the cropping program on the bench-mark farm by a 12.1-acre decrease in soybeans to permit an equal expansion of meadow acreage (see Table 38). The additional hay production is needed for the increased livestock production made possible by the unlimited capital supply. The imputed value productivity of hay is $21.27 per ton. Buying hay in the open market was not considered to be an alternative.

Because of the unlimited supply and low opportunity cost of capital it is profitable to purchase 2450 bushels of grain for livestock feed. Expansion of livestock production is limited by labor as well as forages to 34 litters of hogs and 44 fattening cattle. The low efficiency dairy enterprise, which yields very low returns to labor is not profitable for this farming situation.

Net farm output is $9,584--23 percent greater than output in the bench-mark farm situation. Residual returns to operator and family labor and management are $2,424--60 percent above returns on the bench-mark farm. Average labor-management returns per hour worked are $0.98. However, the imputed marginal value productivity of labor throughout the year is only $0.11 per hour. Even in the critical labor season, early spring for this particular farm, the marginal value productivity of labor is only $0.48 per hour.

The marginal value productivity of land is $26.84 per average acre of land. By comparison, returns in the bench-mark farming situation were only about one half as much. The high value of forage when capital is available to expand livestock production is the major cause of the difference in imputed productivity of land. The high value of forage is reflected particularly in a proportionately greater increase in the imputed productivity of steep cropland which produces primarily forages and permanent pasture.

<u>Differences in labor supply</u>

Part-time farming is quite prevalent in the southern Iowa area and has been increasing considerably in recent years. In order to investigate the effect of a short supply of labor remaining for farm work, a farming situation was analyzed with an assumed labor supply of 1000 hours. The supply of land and capital was unchanged from the bench-mark plan. Custom harvesting of crops was assumed. For contrast, two-man farm with 480 acres of land and unlimited capital was analyzed.

<u>Part-time farm</u> In the part-time farming situation

it is profitable to raise more hay and oats and less corn and soybeans than in the bench-mark situation (see Table 39). This change results primarily from a shortage of labor during May and June when row crops must be planted and cultivated. The production of forage is redundant since there is no use for all of the home-raised forage and no market for surplus hay. However, increased meadow acreage substitutes for some fertilizer and contributes to a slight increase in corn yield at no additional cost.

The livestock program in this part-time situation differs considerably from that of the bench-mark situation. Only 10 litters of hogs are raised. There are no dairy cows due to their high labor requirement. The 15-cow beef herd that is profitable for this plan is the largest for any farming situation studied with the exception of the 480-acre rough farms.

The use of custom harvesting is assumed in the part-time farming situation. Investment in machinery and fixed costs are accordingly lower. However, even with the low fixed costs, residual returns to labor and management are low. Labor-management returns average only $0.31 per hour worked.

The low residual return to labor in this part-time farming situation is the opposite of normally expected high returns when a small amount of labor is combined with a relatively large supply of other resources. The contradictory results arise from the residual imputation procedure.

The marginal value productivity of labor is actually quite high ($2.09 per hour), as would be expected. The marginal value product of land, however, is lower than the annual cost of land. As a result, by residual imputation some return due to labor is incorrectly allocated to pay the annual cost of land. The correct interpretation of the low labor-management returns is that the farmer with only 1000 hours of labor is over-extended on 240 acres of land. He could gain higher net earnings on a smaller farm.

The short supply of labor is most serious during the critical late spring (i.e., May and June) season when requirements for planting row crops are particularly high. The marginal value productivity of labor during that season is $6.15 per hour. Thus, there would be considerable pressure to hire additional labor during that period. However, the alternative of hiring seasonal laborers was not included in the permissable enterprises for profit maximizing farm plans.

<u>Two-man farm</u> In the 480-acre, two-man farming situation crop rotations differ slightly from in the bench-mark situation (see Table 40). Feed grain and hay production are increased more than in proportion to cropland acreage. Soybean production is decreased. The large supply of labor and capital that is available for livestock production is concentrated mostly in an 82-steer feeding enterprise. All of the home grown feeds are used; but, in contrast to the

240-acre situation with unlimited capital, no feed grain is purchased. Twenty-six litters of hogs are raised. Five dairy cows are profitable and the optimum plan shows one beef cow. The linear approximation of production requirements is, undoubtedly, in considerable error when applied to a one-cow enterprise. In actual practice, the resources required by one beef cow would instead be used to expand some other livestock enterprise.

The two-man farming situation is the largest analyzed for the southern Iowa area, as measured by either value of output or annual cost of resources used. Returns to resources are more than twice as large as on the 240-acre farm. A charge of $2,000 for the labor of a hired man is added to the fixed costs making them considerably higher than in any other plan. Labor management returns of $3,708 give an average earning rate of $1.47 per hour of operator and family labor. The imputed marginal values productivities of resources are essentially the same as in the 240-acre, one-man farm with unlimited capital.

Differences in farm size

A 480-acre farm and a 110-acre farm, each with land of average topography, were selected to depict the wide ranges in farm size which exist within the southern Iowa study area. Both farms were allotted an intermediate quantity of capital, budgeted according to the assumptions listed above.

The small farm was assumed to be a part-time farm with only 1000 hours of labor available. The limited opportunities for using labor on the small farm and the imputed value productivity of only $.17 per hour both indicate that an optimum plan assuming a full-time man labor supply would not differ greatly from the plan derived here.

<u>480-acre farm</u> The same crop rotations are profitable for the 480-acre farming situation (see Table 41) as for the bench-mark farming situation. In livestock production, however, the availability of labor is an important restriction to the activities of the large farm. A large cattle feeding enterprise, which requires less labor per dollar of net revenue, comprises most of the livestock output of the 480-acre farm. One-half of the feed grain that is produced is sold. Forages fed are less than production by 61 tons or 24 percent of the total 257 tons produced.

Residual labor-management returns are $1.11 per hour. The imputed marginal value productivity of labor is higher at $1.54 per hour. The value productivity of labor during the July-August hay harvest season is $4.18 per hour. There would be considerable incentive to hire seasonal workers or to adopt labor-saving technology in operations performed during this season. The value productivities of both land and capital are lower than in the bench-mark farming situation.

110-acre, part-time farm   The 110-acre farming situation has the smallest total value output of any farming situation analyzed in this study (see Table 42). Land and labor are in short supply, relative to capital. Crop and livestock production are similar to the 240-acre, unlimited capital farming situation but on a smaller scale. Soybean production must be almost eliminated to allow a shift to feed grain and forage production. Cattle feeding and hog production are the major livestock enterprises. A few (214) bushels of feed grain are purchased for livestock feeding.

Differences in topography of farm land

A farming situation with 240 acres of predominantly level land (see Table 44) and one with 240 acres of predominantly hilly land (see Table 45) are compared to the benchmark situation to indicate the differences in profit maximizing farm plans that follow from differences in the topography of land on the farm. The two farming situations each have a one-man labor supply (2700 hours) and an intermediate supply of operating capital ($6,300). In each case $6,300 of capital is adequate for crop production expenses and investment in enough hogs and beef cows to use up on-farm production of feed grain and forages.

Level farm   The distribution of soils assumed for the farming situation on level land includes more than twice as much high-yielding (class I and class II) land than the bench-mark situation. Row crop acreage is 76 percent higher on the level farm even though total cropland is only 24 percent greater. The ratio of feed grain production to forage production is 2.4 times as large as in the bench-mark situation. As a consequence, hogs are the dominant livestock enterprise. Thirty-nine litters are produced. Eight steers provide some spreading of labor needs throughout the year and a market for permanent pasture.

Residual returns to operator and family labor at $1.15 per hour are considerably higher than the imputed marginal value productivity of $0.10 per hour of labor. The marginal value productivity of land is $23.65 per acre. This figure applies, however, to land that would have a higher-than-average annual cost due to its high proportion of class I and class II soils. Imputed value productivities of the various land classes are slightly lower than in the bench-mark farming situation. An additional acre of farmland composed of the various land classes in the proportion that they occur in the bench-mark farm would increase income about $12.90. By comparison, the marginal productivity of land in the bench-mark farming situation is $13.61 per acre.

<u>Rough farm</u> The land resources of the rough farm are chiefly hilly soils in permanent pasture or in rotations containing a high proportion of forages. On the small acreage of level to rolling land, rotations with as much as 50 percent corn were permitted; however, soybeans were not

considered to be an alternative crop.

Crop production includes only 1605 bushels of feed grain and 126 tons of hay and hay equivalents of pasture. The ratio in production of feed grain to forage is about one-half as large as in the bench-mark situation. The profit maximizing plan is forced by the shortage of grain into a livestock program that will utilize a high proportion of hay and pasture. Seven litters of hogs and 10 beef steers use most of the feed grain supply. Twelve beef cows and 5 dairy cows provide for heavy forage utilization.

Net value of product, at $5,200, is only about two-thirds as great as for the bench-mark farm. Because of the lower annual cost of land, fixed costs are $720 less than in the bench-mark farming situation. Resource returns are not large relative to fixed costs. Net returns are a low $525 per year. Residual labor earnings are only $.35 per hour of operator and family labor used.

The supply of labor does not limit the plan. In an opportunity cost sense, the value of an additional hour of labor is zero for any period within the year. The value productivity of an additional acre of land as it is found on this farm is $9.02. The value of an additional acre of land containing the various land classes in the same proportions as they are found on the bench-mark farm would be $19.64.

Differences in topography and in capital

It is possible that the higher productivity and earning power of a farm on level productive land, as compared to a farm on rough unproductive land, may be partially offset by variations in the supply of operating capital. A 240-acre, cash grain farming situation with level land and a 240-acre, unlimited capital farming situation on rough land were analyzed to investigate the effect of varying both topography and supply of operating capital.

Level, cash grain farm Crop production in the level cash grain farming situation (see Table 43) is exactly the same as in the level, intermediate capital farming situation discussed above. Feed grain and soybean production are respectively 59 and 142 percent greater than in the bench-mark farming situation. Forage production is 32 percent less. Livestock production is limited by the supply of capital to 5 litters of hogs and 5 dairy cows. Most of the feed grain is sold and much of the forage is not utilized.

Net farm output is larger than in the bench-mark farming situation. Fixed costs are also larger. As a result, labor-management returns are approximately one-third less in the level, cash grain farming situation. However, the residual return to labor is $0.68 per hour worked which is exactly the same as residual earnings in the bench-mark farming situation. Therefore, the level, cash grain farm and the bench-mark farm provide almost equivalent opportunities for profitable employing labor.

Rough, unlimited capital farm The 240-acre rough farm with an unlimited capital supply (see Table 47) differs from the comparable farm with an intermediate capital supply primarily in having a much larger hog enterprise. The large hog enterprise (27 litters) is possible because there is adequate capital for purchasing feed grain to supplement on-farm production.

Crop production is not significantly different from that of the rough farm with an intermediate supply of capital.

The livestock enterprise of the rough farming situation with an unlimited capital supply is only slightly larger than that of the bench-mark farm which has only an intermediate supply of capital. It is considerably smaller than livestock production in the 240-acre farming situation with average land and an unlimited capital supply. It differs from both by having 13 beef cows. The more limited scale of livestock production in the rough farm results from the high proportion of low quality permanent pasture in total roughage output. Permanent pasture in the southern Iowa area is not normally suited for hog pastures and cannot be used for all of the pasture requirements of dairy cows or fattening cattle. As a result production of hogs and fattening cattle are curtailed below the amounts that would be possible with the available labor, capital, and potential purchased grain supply.

Labor-management returns on the rough 240-acre farm are only $841, or about 50 percent of returns to labor and management in the bench-mark situation. The imputed value productivity of an additional acre of land is about 3 times as great as its annual cost. The value productivity of labor is only slightly greater than zero.

<u>480-acre, rough, intermediate capital farm</u> The profit maximizing plan for a 480-acre rough farm with a one-man labor supply and an intermediate capital supply (see Table 46) is in most respects a scaled up version of the comparable 240-acre farming situation. Relative crop acreages are unchanged. Beef feeding makes up a larger proportion of the total livestock program. A shortage of labor, especially in the July and August hay harvesting season, makes the change to beef profitable.

Some spreading of fixed costs makes possible a threefold increase in returns to labor and management even though net output is not quite doubled. Labor-management returns are $1,560, about the same as in the bench-mark farming situation. The imputed marginal value productivity of land is slightly lower than in the 240-acre situation but about one-fourth higher, for land of equal productivity, than in the bench-mark farming situation.

<u>480-acre, rough, unlimited capital farm</u> Relaxing capital restraints to permit unlimited borrowing of capital causes little change in the profit maximizing plan for the

480-acre rough farm (see Table 48). With unlimited capital, a 50-percent increase in the hog and beef cow enterprises yields a $574 increase in labor-management returns. Good quality roughage from hay and supplemental pasture is the most important limit to further expansion of livestock production.

Differences due to excluding beef feeding

Beef feeding is, at present, only a small part of livestock production in the southern Iowa area. However, profit maximizing plans for most representative farming situations show some beef feeding to be profitable. Two farming situations were analyzed to depict the farms on which beef are not fed due to considerations other than short-run profit maximization. Two 240-acre, rough, one-man farms, one with an intermediate capital supply (see Table 49) and one with an unlimited capital supply (see Table 50) were used for this purpose. Beef feeding was excluded from the production processes in each case.

Rough farm, intermediate capital Five litters of hogs replace 10 beef steers when the latter enterprise is excluded from the profit maximizing plan of the 240-acre, rough farming situation. The reduction in income due to excluding the beef feeding enterprise is only $126 or $12.60 per steer. The optimum crop production plan is unaffected by the change from beef to hogs. The imputed marginal value productivity of land declines slightly.

Rough farm, unlimited capital No extensive changes are necessitated by excluding beef feeding from the profit maximizing farm plan for a 240-acre rough farm with an unlimited capital supply. Only a 4-steer feeding operation appears as profitable in the unrestricted plan; therefore, the two plans are practically identical. The exclusion of beef feeding from alternatives in this farming situation becomes important only when output of concentrates is reduced.

Typical Northern Iowa Farming Situations

The northern Iowa study area shows a great deal more homogeneity among farms than does the southern Iowa area. Therefore, fewer representative farming situations were needed for analysis of adjustment possibilities. Optimum farm plans were derived for 160-acre and 330-acre farms. A cash grain and an unlimited capital farming situation were investigated within each size of farm. All northern Iowa farming situations have a one-man (2700 hours) labor supply.

Small (160-acre) farms

160-acre cash grain farm The profit maximizing combination of crops in the 160-acre northern Iowa farming situation (see Table 51) is dominated by corn. Corn is grown continuously on 83 acres, the maximum permitted. The remainder of the cropland is in a corn-soybeans-corn-oats-meadow rotation. Less than one-fourth of the total feed grain production is needed for the five litters of hogs and 14 fat cattle that are produced. The remainder of the grain is sold. Some of the forage that is produced is not needed for livestock feeding. Under the assumption of no area market for hay some meadow would be slightly underutilized.

Net farm output of $10,150 is 27 percent larger than for the bench-mark southern Iowa situation. Labor management returns of $2,830 are nearly twice as large as in the southern Iowa situation and are earned with a lesser input of labor. Residual earnings per hour of labor used are $2.37. The imputed value productivity of an additional acre of land is $44.83--more than twice the annual cost for interest and taxes on average value land.

<u>160-acre, unlimited capital farm</u> Relaxing the restriction on the quantity of capital used permits a sizeable expansion of livestock production in the 160-acre northern Iowa farming situation (see Table 53). A 40-litter increase in hog production is the primary component of the increase in livestock production. Even so, a small amount of feed grain is sold off the farm. The size of the hog enterprise is limited by the supply of labor in March and April when both corn planting and farrowing have large labor requirements.

Further expansion of livestock production by a substitution of beef cattle for hogs is limited by availability of roughages. Cropland meadow acreage, at 22 acres, is twice as large as in the cash-grain situation. Further expansion of livestock production would require a shift of additional land from corn to meadow production. Marginally, each acre shifted would result in a loss of about $2.50. Plans with somewhat more forage and less corn might be considered to be optional alternatives, with slightly less profit, to the plan that is presented.

Net output is increased 25 percent through the use of the additional capital. Labor management returns are increased by about one-third. However, because of the greater quantity of labor being used, residual earnings imputed to labor are reduced to $1.45 per hour. The critical scarcities of early spring labor and of roughages are reflected in high imputed marginal value productivities.

Large (330-acre) farms

330-acre, cash grain farm A 330-acre farming situation was used to depict large farms in the northern Iowa area. The 330-acre farm was assumed to have a 4-plow tractor with 4-row equipment and a smaller tractor for light work. The labor supply is the same as for the 160-acre situation.

When capital is limited in supply, the pattern of crop production in a 330-acre northern Iowa farming situation (see Table 52) is simply scaled up from the 160-acre farm with a comparable capital supply. Corn is by far the most important crop. If permitted, shifting land from the corn-soybeans-corn-oats-meadow rotation to continuous corn would increase income at the margin by $10 per acre. Livestock production is limited by the availability of capital. Less than one-sixth of the feed grain and only a small proportion of the roughage produced are fed on the farm.

Fixed costs are spread over a larger output than in the 160-acre situation. The resulting savings permit a higher labor-management return. Residual labor earnings are $3.78 per hour. No returns are imputed to labor by the linear programming procedure since the combination and size of enterprises is not limited by labor supply in any of the five time periods.

330-acre, unlimited capital farm The addition of an unlimited supply of capital to the 330-acre northern Iowa farm permits only relatively small adjustments in production (see Table 54). Livestock production is limited by the amount of labor remaining after satisfying the requirements of the large crop production program of this farm. Because of the labor limitation to livestock production almost three-fourths of the feed grain produced on the farm is sold rather than being fed. Thus, this farm could be considered to be a cash grain farm on the basis of proportional composition of total farm output even though supply of capital is not limited.

EFFECT OF OUTPUT CONTROL ON PRODUCTION OF INDIVIDUAL FARMS

The effect of output control on crop and livestock production in the representative farming situations is presented in this chapter. The effects presented in this chapter are in terms of physical quantities or monetary quantities based upon constant prices. Price and income changes due to aggregate effects are not taken into consideration. They will be discussed in the following chapter. The effects shown are those that would result from an imposed mandatory reduction in feed concentrate output or a voluntary reduction for which compensation was received. The effects of output control (at a given amount of reduction) are measured by the difference between the plan that maximizes profits with a reduced output and the profit maximizing plan with no controls on output. The comparison of the two plans is made in a static setting. It is assumed that the period of adjustment to an output reduction has passed and the new equilibrium output has been reached when the measurement of the effect of a reduction in concentrate output is made.

Profit maximizing plans with reductions in concentrate output ranging from 0 to 100 percent of uncontrolled output were derived by a parametric programming procedure. However, results are presented at only three selected levels of reductions, 10, 20 and 40 percent of uncontrolled feed concentrate output. These three points adequately portray the nature of response to output control. In Appendix B, Tables 36 to 54 give profit maximizing plans at each of the three reductions for the representative farm situations.

Product Substitution in Response to Feed Concentrate Output Control

Control of feed concentrate output is a restraint to potential profit-making activities of the individual farm firm. The reaction of a profit maximizing entrepreneur to a control of concentrate output will depend upon the production possibilities which are available to the firm and the product price ratios. Usually opportunities will exist within the production possibilities of the firm to substitute expanded output of alternative products in response to a reduction in output of feed concentrates. Only rarely will a firm have as its most profitable response either no change in the output of alternative products or a proportionate complementary reduction in the output of alternative products as output of feed concentrates is reduced.

Substitution between products in production has been discussed by Heady (21, pp. 237-256) and, in connection with production control, by Roberts (45, pp. 27-48). A hypothetical production possibility frontier for a simplified, two-good case is shown in Figure 1. Feed concentrate output

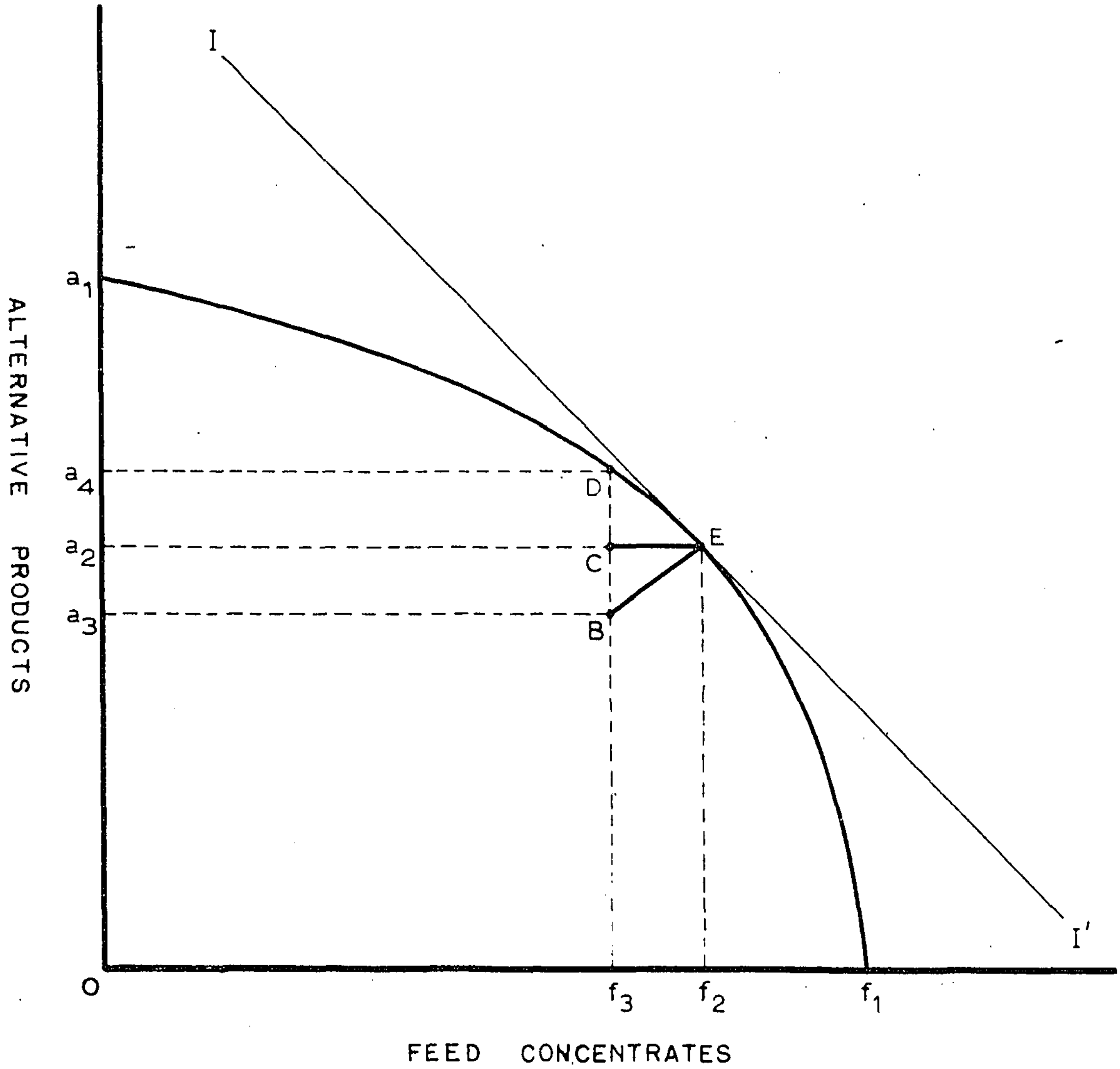

Figure 1. Hypothetical production possibility frontier for an individual farm relating output of feed concentrates and output of alternative products

and output of other products that may be obtained by the hypothetical firm as a maximum output from fixed resources and a specified amount of variable resources are shown by the boundary (frontier) a_1f_1. Both feed concentrate and the alternative product are assumed to be measured in value terms. Therefore, the profit maximizing combination of products is given by point E where the slope of the production possibility frontier (marginal rate of substitution of the alternative product for feed concentrate) is equal to -1.0. The income-line II' has slope -1.0. Other income lines parallel to II' but closer to the origin depict lower incomes.

Points B, C and D represent combinations of the alternative product and feed concentrates that meet a specified reduction from of_2 to of_3 feed concentrate output. Point B represents a proportionate reduction of both feed concentrates and the alternative product. Point C represents an unchanged output of the alternative product as output of feed concentrate is reduced.

At point C the proportion of the alternative product in total output is increased, although the absolute amount is unchanged. Point D represents an increase in output of the alternative product from oa_2 to oa_4 as output of feed concentrates is reduced from of_2 to of_3. Point D is on the production possibility boundary. The output oa_4 is the maximum output of the alternative product when output of feed concentrates is at of_3. An income line parallel to II' through point D will be higher than the income line through either point C or point B. Therefore, D represents a combination of products giving greater income through substitution of an increased output of the alternative product. No income line parallel to II' passing through a point within or on the production possibility boundary and to the left of f_3 will be above the line passing through D. Therefore, income from the combination of products given at D is the maximum attainable with the conditions of a specified maximum output of feed concentrates of of_3.

Substitution of Soybeans for Corn

Corn, soybeans and oats all contribute to total feed concentrate output. Control of total concentrate output, as applied in this study, imposes no restraint on the relative importance of the three crops in the composite total output. Substitution among feed concentrate producing crops is permitted within the limits of the permissible rotations. Substitution of soybeans for corn is the most important change that takes place as concentrate output is reduced. Oats production is largely determined by rotational requirements rather than profit maximizing choice. Changes in oats production take place but are of minor importance as an adjustment to direct production control.*

The substitution of soybeans for corn as concentrate output is controlled results from the higher market return of soybeans per unit of feed content. The additional market return to soybeans is accounted for by the value of non-feed oils which are extracted from the soybeans. The price and feed content per bushel of soybeans and corn that were estimated for use in this analysis were

	Soybeans	Corn
Price per bushel	$2.44	$1.25
Feed value per bushel	1.65 feed units	1.00 feed units.

The market value per feed unit from soybeans is $2.44 / 1.65 = $1.48 as compared to $1.25 / 1.00 = $1.25 for corn. As a result, when feed concentrate output is restricted and quota to produce concentrate crops is an important limitation upon production (i.e. a scarce resource) substitution of soybeans for corn is a means of increasing returns to the scarce quota resource.

Comparatively greater returns from using quota to produce soybeans may be counterbalanced by relatively inefficient use of other resources by soybeans. More land is

*Some sizeable adjustments in oats acreage have accompanied past programs that specified a maximum acreage rather than production of grain crops. Within that context, substitution of either corn or soybeans for oats is often profitable as a means of increasing yield per acre.

required to produce a given amount of feed concentrate output with soybeans than with corn. For example, replacing one year of corn by soybeans in a typical five-year rotation* on class II southern Iowa land increases by 11 percent the acreage required to be in rotation for the same total output of concentrates. On class I southern Iowa land a similar substitution does not require quite as great an increase in amount of land used. On northern Iowa land a greater increase in land used would be required to maintain total output.

A high imputed value for grain for feeding on the farm where produced also may offset the high market value for concentrates in the form of soybeans. Although soybeans add to total feed concentrate output they are not normally fed unprocessed on the farm where they are produced. Therefore, substitution of soybeans for corn reduces the supply of home-grown grain available for livestock feeding. When the supply of home-grown feed grain is an important limitation to livestock production (i.e., feed grain has a high imputed value) it may not be profitable to substitute soybeans for corn.

Weighted average for southern Iowa

The weighted average acreage and production of feed concentrate crops on southern Iowa farms with no controls

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*Corn-soybeans-corn-oats-meadow.

and with 10, 20 and 40 percent reductions feed concentrate output are shown in Table 9. The weighted averages were derived by use of the relative frequency weights for the aggregation model and the results of analyses of representative farming situations. They provide a summary view of response on southern Iowa farms. Results of analyses of individual representative farms will be discussed in more detail below.

A tendency to substitute soybeans for corn is evident in Table 9. Soybean acreage increases an average of 2.5 acres per farm, or about one-fourth, when production is adjusted to maximize profit with 10 percent less output of feed concentrates. Corn acreage decreases by almost three times as much as soybean acreage increases and acreage of oats is virtually unchanged. Substitution of soybeans for corn continues with a 20 percent reduction in feed concentrate output. With a 40 percent reduction in feed concentrate output, soybean acreage declines along with corn acreage. However, the rate of decline in soybean acreage is much slower than the rate of decline in corn acreage. Therefore, the proportion which soybeans comprise of total concentrate output continues to increase.

<u>Individual farming situations</u>

<u>Cash grain farms</u> Cash grain farms are able to profit most from the opportunity to substitute soybeans

Table 9. Acreage and production of feed concentrate crops (average per farm in southern Iowa with no controls and with 10, 20 and 40 percent reduction in concentrate output as estimated by aggregation of profit maximizing farm plans)

Item	Unit	No controls	Reduction in output 10%	20%	40%
Acreage of concentrate crops					
Average per farm					
Corn	acres	55.7	48.6	37.0	22.7
Soybeans	acres	10.8	13.3	16.6	16.0
Oats	acres	23.0	23.3	21.9	16.0
Total	acres	89.5	85.2	75.5	54.7
Percentage composition of total acreage					
Corn	percent	62	57	49	42
Soybeans	percent	12	16	22	29
Oats	percent	26	27	29	29
Production of concentrates					
Average production per farm					
Feed grains	feed unit	2766	2372	1956	1332
Soybeans	feed unit	398	460	561	543
Total	feed unit	3164	2832	2517	1875
Percentage composition of total production					
Feed grains	percent	87	84	78	71
Soybeans	percent	13	16	22	29

for corn as total concentrate output is controlled. Land is typically in excess supply when output is controlled and thus has zero marginal opportunity cost for use in feed concentrate production. Therefore, the slight inefficiency of soybeans relative to corn in the use of land is of no consequence to the selection of one crop or the other.

Cash grain farms, as the name implies, are grain selling farms. Production of feed grain is greater than the feed requirements of livestock on the farm. Feed grain has no imputed value above market price. Thus, maximum market returns from a feed concentrate output is the value to be maximized.

All cash grain farming situations analyzed show substitution of soybeans for corn at all levels of output reduction. In Table 10 the cash grain farming situations (farms no. 3, 8, 16, and 18) all show an increasing proportion of soybean production in total concentrate output as total feed concentrate output is controlled. Northern Iowa farming situations (farms no. 16 and 18) show approximately the same pattern of response as do the southern Iowa farms.

<u>Farms with unlimited capital</u>   Farms with an unlimited supply of capital have opportunity to benefit both from more efficient use of land and from greater production of land. A livestock program that uses all home-grown grain and forage is possible on all except the largest of these farms. (Among the unlimited capital farming situations analyzed only farm no. 19, the 330-acre northern Iowa farm, had significant amount of grain production in excess of feed requirements.) The availability of capital also makes it possible to adjust livestock enterprises to use greater amounts of forage when a reduction in feed concentrate output forces

Table 10. Percentage of soybeans in total feed concentrate output of representative farms with no controls and with 10, 20 and 40 percent reduction in concentrate output (estimated by profit maximizing farm plans)

Farm number[a]	No controls	Reduction in output 10%	20%	40%
	(%)	(%)	(%)	(%)
1	16.5	21.1	9.3	38.8
2	5.2	5.8	0	0
3	16.5	16.2	38.6	51.5
4	5.0	5.6	6.2	1.8
5	4.7	5.2	2.9	0
6	16.5	25.6	35.2	28.3
7	4.7	2.7	0	0
8	22.1	40.4	53.4	53.0
9	22.1	31.7	43.2	29.9
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	7.0	22.5	19.7	35.1
17	0	0	0	0
18	7.0	17.3	34.1	42.1
19	0	0	11.1	0.7

[a]Refer to Table 7, p. 40, for a description of farming situations by farm number.

land out of crop production. Substitution of soybeans for corn would reduce forage production by requiring that more land be used to produce the same total output of feed concentrates. In addition, substitution of soybeans for corn would reduce the supply of home-grown grain and, in most cases, necessitate the purchase of a larger amount of grain for livestock feed. Consequently, substitution of soybeans for corn will not generally be profitable on farms with an unlimited supply of capital.

In Table 10, the observed low proportion of soybeans in total feed concentrate output for farms which have an unlimited capital supply (farms no. 2, 5, 17 and 19) substantiates this hypothesis. With a reduction in concentrate output, these farming situations change to even less production of soybeans. The only exception is farm no. 19 which produces 11.1 percent soybeans at a 20 percent reduction in concentrate output.

<u>Farms with an intermediate supply of capital</u> The farming situations with an intermediate supply of capital do not show the generally uniform pattern of substitution between soybeans and corn that was exhibited by the cash grain and unlimited capital farm situations. The margin of profit from substituting soybeans for corn or vice versa on the farms with intermediate capital is small. The direction of substitution varies between farms according to the particular resource structure and between plans for different levels of output control on the same farm.

Profit maximizing plans for both farm no. 6 and farm no. 9 show substitution of soybeans for corn in about the same pattern as was found on cash grain farms. One of these farms has 240 acres of level land and the other 480 acres of average land. Both have one-man labor and intermediate capital supplies. Each is limited in livestock production, when there are no controls on output, by availability of labor. Soybeans use labor at approximately the same rate of efficiency as does corn. Therefore, soybeans are substituted for corn as an efficient means of using scarce concentrate output quota.

Farms no. 4 and no. 7, also with intermediate capital supplies, follow a pattern similar to farms with unlimited sources of funds in that corn is substituted for soybeans. Both of these farms have a part-time labor supply. Farm no. 4 has 240 acres and farm no. 7, 110 acres of average productivity land. On the 110-acre farm, land is scarce relative to other resources. Corn substitutes for soybeans in order to maintain feed grain supplies for livestock production and to minimize the amount of land required for grain production. On the 240-acre farm, labor is the critical resource. Forage and grain are more than adequate for livestock production with reductions in concentrate output of as much as 40 percent. Ordinarily, with abundant feed resources being available, it would be profitable to substitute some soybean production for corn production. However, a reversal of the usual trend is brought about by a slightly more efficient use of labor by corn. For this part-time farm it was assumed that grain crops would be custom harvested. Output of concentrates from the same amount of labor is about 10 percent less on class II land with one acre of soybeans substituted for one acre of corn in a five year rotation.

Farm situation no. 1, a 240-acre, average, one-man, intermediate capital farm, shows slightly increased soybean acreage and production with either a 10-percent or 40-percent reduction in concentrate output. However, when concentrate output is reduced by 20 percent a reduction in soybean acreage is profitable in order to maintain grain production and avoid the necessity of reducing livestock production.

Policy implications

Substitution of soybeans for corn as output of concentrates is reduced is a desirable development provided it does not take place to an extensive degree. The 1960 soybean crop sold at an average price well above its long-run relation to corn. The demand for soybeans has increased considerably in recent years and is expected to continue to increase. However, the demand for soybeans is not completely elastic. A U.S. Department of Agriculture report states that "...production of oilseed crops could easily become overexpanded and cause surpluses to develop or prices to decline seriously. For this reason, oilseed crops must be considered in the development of any general farm program." (67, p. 81). Undoubtedly, control of corn production in the Corn Belt region without associated control of soybean production would lead to expansion of soybean output. A control program formulated as in this study with both feed grains and corn included in an aggregate variable to be controlled would apparently lead to some substitution of soybeans for corn. However, it does not appear that the overall increase in soybean production would be large enough to cause serious difficulties.

Substitute Uses for Land Diverted from Grain Production

Some reduction in acreage of grain crops is usually either necessary or profitable to achieve reductions in output of feed concentrates. The output control program analyzed in this study applied only to concentrate crops and not to forage crops. Therefore land, labor and capital released from the production of concentrate crops may be diverted to the production of forages.

Resources released from the production of concentrate crops will be diverted to forage production only if there is a potentiality for using additional forage as feed for livestock or if there is a market for forages. In this study, it was assumed that individual farms could not plan production with the expectation of having a market either for sale or purchase of forage. Thus, forage production is only profitable when livestock production can be either expanded or adjusted to make use of the added forage output. When there is no possibility for using the forage in livestock production land diverted from grain production remains idle.

Weighted average for southern Iowa

In Table 11 acreages in grain crops, forage crops and cropland not harvested or pastured are shown for the weighted average of the southern Iowa farming situations. Also included in Table 11 is an average utilization rate for permanent pasture. The average utilization rate is the percentage that actual stocking of the pasture is of normal carrying capacity. Some forage may be produced as a supplementary output from soil conserving crops in rotation with grain crops. When supplementary forage production exceeded livestock feed requirements in profit maximizing farm plans, the land producing the surplus forage was assumed to be not harvested. In actual practice, it would be expected that excess forage production on cropland would result in some general underutilization as well as in nonuse of forage crops.

Table 11. Cropland and permanent pasture by use (average per farm in southern Iowa with no controls and with 10, 20 and 40 percent reduction in concentrate output as estimated by aggregation of profit maximizing farm plans)

Item	Unit	No controls	Reduction in output		
			10%	20%	40%
Grain crops	acres	89.5	85.2	75.5	54.7
Forage crops	acres	38.8	43.5	45.0	46.9
Cropland not harvested and not pastured	acres	9.7	9.9	18.1	37.0
Total	acres	138.6	138.6	138.6	138.6
Permanent pasture percent utilization	%	63	81	85	87

In the profit maximizing plans based on the assumption of no control over output of concentrate crops all land is used for crop production in all of the representative farming situations. Forage produced on permanent pasture or as a supplemental output to grain production is not completely utilized in the farm situations with limited capital supplies. The average excess of forage production for the southern Iowa area as aggregated from the profit maximizing plans for representative farms is equivalent to 9.7 acres of rotation meadow not harvested or pastured and 37 percent underutilization of permanent pasture. With reduction in concentrate output, both the acreage of cropland used to produce forage and the acreage of cropland not harvested and not pastured increase. With a 10 percent reduction most of the increase is in forage acreage. For larger reductions the increase is primarily in cropland not harvested or pastured. At the same time, the indicated rate of utilization of permanent pasture increases. However, the division between underutilization of permanent pasture and cropland not harvested and not pastured is partly arbitrary. It was assumed that forage produced as a supplemental crop in rotation with grain crops would be used before permanent pasture.

Individual farming situations

Forage production for individual representative farming situations is shown in Table 12 for an uncontrolled output

Table 12. Forage produced and used[a] on representative farms with no controls and with 10, 20 and 40 percent reductions in feed concentrate output (estimated by profit maximizing farm plans)

Farm number[b]	No controls	Reduction in output 10%	20%	40%
	(tons)	(tons)	(tons)	(tons)
1	83	94	97	107
2	152	167	179	197
3	24	43	33	37
4	91	97	99	103
5	251	315	346	387
6	197	240	212	298
7	59	66	72	78
8	34	38	42	48
9	51	70	85	95
10	125	122	118	132
11	225	220	226	261
12	131	138	144	151
13	263	282	294	307
14	108	117	113	116
15	126	135	140	147
16	22	39	64	61
17	73	104	131	173
18	9	70	77	81
19	51	156	198	348

[a]Forage produced but not used represents cropland not harvested and not pastured.

[b]Refer to Table 7, p. 40 for a description of farming situations by farm number.

and for 10, 20 and 40 percent of reductions in feed concentrate output. Forage production is measured in hay equivalent tonnage actually harvested or pastured, and includes forage produced on permanent pasture. In Table 13 cropland not harvested and not pastured is shown at each of the same points.

Table 13. Cropland not harvested and not pastured on representative farms with no controls and with 10, 20 and 40 percent reductions in concentrate output (estimated by profit maximizing farm plans)

Farm number	No controls	Reduction in output 10%	20%	40%
	(A.)	(A.)	(A.)	(A.)
1	1.2	9.5	35.8	46.3
2	0	0	0	0
3	33.1	24.1	40.8	85.9
4	6.7	28.9	57.7	79.3
5	0	0	0	0
6	0	0	46.1	43.5
7	0	0	0	3.7
8	19.5	13.6	42.2	79.8
9	5.1	0	0	57.2
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	9.2	17.5	29.2
15	0	0	0	0
16	3.7	0	0	14.3
17	0	0	0	0
18	19.8	0	0	47.8
19	0	0	0	0

<u>Farms with a limited capital supply</u> Farms with a limited supply of capital have only limited capability to utilize output of forages. Capital limitations prevent these farms from expanding forage-consuming livestock enterprises to the extent necessary to utilize profitably all the forage production potential of land diverted from production of grain crops. As a result, some cropland is unused when output of concentrates is reduced beyond the amount of reduction that can be obtained by reducing the

rate of fertilization and substituting soybeans for corn. (For example, see Table 13, farms no. 1, 3 and 14.)

Farms with unlimited capital supply   Farming situations with an unlimited capital supply are able to utilize fully the increased forage production potential that follows from reduced production of concentrate crops. Capital for expanding beef cattle production is a particularly crucial factor making this adjustment possible. In Table 12 forage production increases rapidly as output of concentrates is reduced on farming situations having unlimited capital funds. (For example, see farms no. 2, 12 and 17.) None of the farming situations with unlimited capital find it necessary to leave any land unused when concentrate output is reduced. (See Table 13, the same farms--no. 2, 12 and 17.)

Policy implications

Substitution of forage crops for grain crops has both desirable and undesirable aspects. Conservation of soil resources has received considerable support as an agricultural policy goal. Forage crops result in considerably less soil erosion than do grain crops. Therefore, the goal of soil conservation is advanced by a substitution of forage crops for grain crops as concentrate output. However, forages can be substituted for grains in livestock feeding. The range of substitution is quite wide when the possibility for substituting forage-consuming livestock for grain-consuming livestock exists. Therefore, production of forages, which can serve as a substitute in livestock feeding, will dampen the ultimate effect of concentrate control upon livestock production.

Idling of land diverted from concentrate production would be a more desirable response from the standpoint of obtaining maximum reduction in total feed and livestock production. Of course it would be necessary for idled land to have adequate cover if conservation benefits equivalent to those from forage production are to be realized. In the southern Iowa area, where steep land is particularly in need of cover, the existence of a high proportion of meadow and hay crops would make seeding of a cover crop unnecessary on approximately 50 percent of the land.

Substitution in Livestock Production

A program of direct control over feed concentrate output imposes no direct restraints upon livestock production. Subsidiary restraints could be placed upon livestock output. However, the program analyzed in this study assumes that this is not the case.

Control of concentrate output does have an indirect effect upon livestock production through its effect upon supplies of feed and other resources. Capital limitations make it unprofitable for many farming situations to buy grain to replace a reduction in grain supply. But reduced grain production frees resources for forage production. As a result a shift from grain consuming livestock to forage consuming livestock is profitable on most farms.

Net returns per bushel of grain fed and the proportion of feed grain in total feed requirements are important determinants of the relative profitability of livestock enterprises as concentrate output is controlled. These two values are given in Table 14 for each of the livestock enterprises used in this study. The net value per bushel of grain fed is computed as gross returns minus variable costs and a charge of $0.06 per dollar of operating and investment capital. No charge is made for forage and labor used. An internal opportunity cost for the use of either forage or labor or an imputed marginal opportunity cost of more than $0.06 per dollar on capital would alter the ratios in Table 14. Total feed requirements were computed on the basis of one feed unit per bushel of corn and 15 feed units per ton of hay or hay equivalent units of pasture.

Hogs have the lowest rate of return per bushel of feed grain consumed of any livestock enterprise used in this study. They also have the largest proportion of grain in total feed requirements. Nevertheless, hogs dominate profit maximizing plans when there are no controls on grain production because they yield high returns to capital and forages.

Table 14. Net returns above operating costs[a] per bushel of grain fed and proportion of grain in total feed requirements for typical livestock enterprises used in linear programming models

	Net returns per bushel of feed grain fed	Proportion of grain in total feed requirements[b]
Hogs		
2 spring: 1 fall	$1.42	.92
With added facilities	1.28	.92
Summer	1.33	.88
Beef steers		
Yearlings, short-fed	1.36	.91
Yearlings, pasture fed	2.23	.51
Calves, deferred fed	1.77	.61
Beef cows		
450 lb. calf sold	9.70	.08
1000 lb. fat cattle sold	2.73	.30
Dairy cows	3.70	.25

[a]Capital used for operating costs and for investment in livestock is charged at the rate of $0.06 per dollar used. No charge is made for forages or labor used.

[b]Feed grain and hay evaluated in feed units with one ton of hay assumed to have feeding value equal to 15 bushels of corn.

However, when grain becomes very scarce as a result of control over the output of feed concentrates, the low return on grain fed to hogs causes them to be less profitable than other livestock enterprises. Yearling beef steers short-fed in a dry lot have about the same rate of return to grain fed as do hogs. Other cattle feeding enterprises have a higher rate of return per bushel of feed grain fed than do hogs. Beef feeding enterprises tend to be substituted for hogs when the supply of grain becomes a critical limitation to livestock production. Dairy cows yield a slightly higher return per bushel of feed fed than do beef feeding enterprises. Highest returns in the use of feed grain are gained from the beef cow enterprise which gets most of its feed requirements from forages. When feed grain is very scarce and other resources have a relatively low opportunity cost beef cows will tend to be substituted for other types of livestock.

Weighted average for southern Iowa

The weighted average of livestock production on southern Iowa farms is shown in Table 15. The average number of litters of hogs produced per farm decreases regularly with successively larger reductions in feed concentrate output. Counteracting the decrease in hog production is an increase in the average number of beef cattle fattened. Both beef cow and dairy cow numbers decline slightly from an output with no controls to an output with 20 percent reduction in feed concentrate production. However, with a 40 percent reduction in output of concentrates cow numbers increase slightly to provide an outlet for more forage. With reductions of more than 40 percent (not shown here), the increase in cow numbers would be even more substantial. Also, it

Table 15. Livestock numbers (average per farm in southern Iowa with no controls on output and with 10, 20 and 40 percent reduction in concentrate output as estimated by aggregation of profit maximizing farm plans)

Item	Unit	No controls	Reduction of 10%	20%	40%
Hogs	litters	13	10	8	6
Fat cattle	head	16	21	24	23
Beef cows	head	5	3	2	5
Dairy cows	head	3	2	2	3

should be mentioned that present livestock production in the southern Iowa area (refer to Table 2, p. 20 above) shows a much larger number of beef cows and smaller number of cattle fattened than result from aggregation of the profit maximizing plans with no controls. This discrepancy may be due to non-economic reasons, such as preference for low risk enterprises, personal preference for raising calves rather than feeding steers or erroneous evaluation of alternatives. If so and if the same reasons persist under conditions of output control, the increased cattle production in response to output control would likely take the form of increased beef cow numbers rather than larger cattle feeding operations.

Individual farming situations

Cash grain farms   Control of concentrate output has little effect upon the small livestock enterprises of the cash grain farms. Hog production remains unchanged at the maximum permitted 5 litters in all of the farm plans when output is reduced by 40 percent or less. Capital freed from use in crop production is used to expand cattle feeding and dairy enterprises. The relative importance of these two enterprises in expanded cattle production varies from farm to farm and with different levels of output control. The exact division between the beef feeding and dairy enterprises is inconsequential from the standpoint of farm income on these cash grain farms. For example, in the 160-acre northern Iowa farm (farm no. 16, Table 51) dairy cows substitute for beef with a reduction of 17 percent or more in concentrate output. However, substituting dairy for beef at a lesser reduction in output would result in a marginal loss in income of only $0.60 per dairy cow.

Farms with an intermediate capital supply   Substitution in livestock production is more complicated and more varied among the farms with an intermediate supply of capital than it is among the cash grain farms. The high opportunity cost of capital makes purchase of feed grain prohibitively expensive to farms with a limited supply of capital. Therefore, as grain production is reduced under the impact of concentrate output control, the livestock enterprise must be reorganized on all farms not having some sales of surplus grain when farm output was uncontrolled.

The major portion of the adjustment in grain feeding as output of concentrates is controlled on intermediate capital farms comes about through a reduction in the number of litters of hogs. The number of beef cattle fattened is increased to provide employment for capital and a part of the labor released by the reduction in crop production and in hog numbers. This pattern of adjustment is exemplified in farms no. 1, 7 and 9 (see Tables 36, 42 and 44).

Farms no. 10 and 11, 240- and 480- acre farms on rough southern Iowa land, have a slightly different pattern of response because of the relatively greater importance of cattle production in the profit maximizing plan without controls on output. A 10 percent or 20 percent reduction in concentrate output on these farms brings some reduction in the size of the beef cow enterprise to free additional capital and forages for an expanded cattle feeding enterprise. A reduction of 20 percent in concentrate output forces complete elimination of the hog enterprise. To keep grain consumption within the bounds of production with a 40 percent decrease in concentrate output, it is necessary to reduce the size of the cattle feeding enterprise and use the capital instead for an expanded beef cow herd.

Farm no. 14 is a rough, 240-acre, southern Iowa farm with no beef steer feeding enterprises included among alternative production processes. Within the limited alternatives available to this farm, an adjustment to reduced grain production is made by a proportionate reduction in litters of hogs raised. The beef cow herd can be expanded to use excess capital and labor.

The two farming situations with shortages of labor in comparison to the amount of other resources available (farms no. 4 and no. 6) both have an excess supply of grain when concentrate output is not controlled. As grain production is curtailed, labor and capital are shifted to cattle feeding enterprises. In the 240-acre farming situation the number of hogs raised remains unchanged for reductions in output of up to 20 percent. In the 480-acre farming situation no hogs are produced.

Farms with an unlimited capital supply The farming situations formulated with an unlimited supply of capital have a considerably greater amount of flexibility in adjusting to imposed reductions in grain output than do those farms with limitations on capital used. A relatively inexpensive capital supply provides the capability for purchasing feed grain and for expanding the numbers of forage consuming livestock.

Adjustments in livestock production on the farms with unlimited capital follow the same general pattern as on farms with an intermediate supply of capital. The adjustments differ from those of the intermediate capital farms, however, both in magnitude of change and in the primary reason for change.

In the farm situations with an unlimited capital supply, the increase in grain consumption by an expanded beef feeding enterprise approaches or exceeds in most cases the decrease in grain consumption by a contracted hog enterprise. Purchased grain is used to supplement farm-produced grain. Supplies of labor and forages are the primary limitation on livestock production. Both of these resources are available in greater amount for livestock production when grain production activities are restricted. As a result, total livestock production is expanded rather than contracted as grain production is controlled on farms with unlimited supplies of capital.

Policy implications

Substitution of beef production for pork production as output of concentrates is reduced would have some desirable aspects from the aggregate point of view. The price elasticity of demand for beef is higher than that of pork.*
Therefore, there may be some possibilities for aggregate

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*Shepherd and others (51, p. 19-20) summarized findings of several studies and concluded that the price elasticity of demand for beef is about -0.6 and that the price elasticity of demand for pork is about -0.4.

income gains by substituting an increase in beef production, at a relatively small decline in price, for a decrease in pork production, at a relatively large increase in price.

Substitution of Purchased Grain for Home-grown Grain

Closely related to changes in livestock production are changes in purchase and sale of corn as feed concentrate output is controlled. The opportunity to either purchase or sell corn at a constant price regardless of quantity was made available in every representative farming situation. The sale price was a constant \$1.25 per bushel. The purchase price was \$1.35 per bushel, \$0.10 per bushel higher to cover marketing and handling charges.

It was assumed that all grain purchases required capital funds equal to the full purchase price of the grain. The use of capital for grain purchases is competitive with other uses in the firm when the supply of capital is limited. The opportunity cost of purchased grain when the opportunity cost of using capital is considered is

$$\$1.35 \times (1.00 + MVP_{cap})$$

where MVP_{cap} is the marginal value productivity of capital at its most profitable use within the firm. The cost of capital acts to curtail the use of grain purchases as a means of avoiding the necessity of adjusting livestock production to the available supply of home-grown grain.

Weighted average for southern Iowa

Aggregation for the southern Iowa area of results from individual representative farm analyses gives an estimated average net sale of feed grain of 447 bushels (corn or corn equivalent) per farm. That is, sales of feed grain within the area exceeded purchases by an average of 447 bushels per farm. This amounts to 16 percent of estimated average grain production per farm. Although definitive information is not available, general indications are that this area is a net grain importing area. The overestimation of feed grain sales in the profit-maximizing model may be due to underestimation of soybean acreage or of livestock numbers. Apparently corn acreages and yields are approximately in agreement with present actual acreage and production.

With a reduction in concentrate output the estimated net grain sales of the southern Iowa area decline rapidly. Average net purchases of grain per farm in the southern Iowa area were estimated to be:

No controls	-447 bu.
10% reduction	-127 bu.
20% reduction	182 bu.
40% reduction	493 bu.

Negative values indicate sales. With a 20 percent reduction in concentrate output purchases exceed sales for the average of the farming situations.

Individual farming situations

Net purchases of feed grain in the profit maximizing plans of representative farms are shown in Table 16. Negative quantities indicate sales.

Cash grain farms To the cash grain farms, the high opportunity cost of purchased grain is of no consequence for reductions of 40 percent or less in concentrate output. Because of limitations on livestock production, the marginal value productivity of grain for feeding declines rapidly with increases in the amount fed and is equal to or greater than the selling price of corn for only a small proportion of normal grain output. As a result, all cash grain farming situations show sales of feed grain produced in excess of the amount that can be profitably fed. Sales continue to be profitable with reductions of as much as 40 percent in concentrate output.

Farms with an intermediate capital supply Farms with an intermediate supply of capital (as defined in this study) usually can profitably feed all grain produced on the farm when output of concentrates is not controlled. In column 1 of Table 16 farms no. 1, 10, 11 and 14 show neither sales nor purchases of feed grain. Farms no. 7 and 9 show very slight deviations from an exact balance within the farm of production and consumption of feed grains. Only farms no. 4 and 6, which are forced into a beef-cash grain type of farming program by a shortage of labor, show sizeable sales of grain.

The reduction in feed grain supply forces some

Table 16. Net purchases of feed grain[a] on representative farms with no controls and with 10, 20 and 40 percent reduction in concentrate output estimated by profit maximizing farm plans

Farm number[b]	No controls	Reduction in output 10%	20%	40%
	(bu.)	(bu.)	(bu.)	(bu.)
1	0	0	0	0
2	2451	2987	2466	3058
3	-2090	-1670	-722	-102
4	-1951	-1468	-992	-209
5	0	2454	2825	4086
6	-3170	-1958	-420	0
7	214	-97	0	0
8	-4188	-2618	-1527	-903
9	-112	0	0	0
10	0	0	0	0
11	0	0	0	0
12	1933	1048	1299	1531
13	593	2227	2312	3049
14	0	0	0	0
15	1658	2078	1963	2458
16	-5226	-3476	-3009	-1518
17	-562	742	1634	2629
18	-12085	-9893	-6511	-3695
19	-11023	-9616	-5916	-4471

[a]Sales are indicated by negative quantities.

[b]Refer to Table 7, p. 40 for a description of farming situations by farm number.

curtailment of livestock production in those farms that operate at or near a production-consumption balance for feed grains when output is not controlled. The high opportunity cost of diverting capital from other uses makes feed grain purchases prohibitively expensive to the intermediate capital farm situations analyzed in this study. The net purchases listed in Table 16 indicate that it was not profitable for any feed grain to be purchased by these farms with reductions in the range of 10 to 40 percent of concentrate output. The fact that a balance between production and consumption of feed grains is maintained as output is controlled is a factor in the shifts in livestock production which were discussed above.

Farms with an unlimited capital supply Farm situations with an unlimited supply of capital have more opportunity to utilize profitably purchased feed grain. An ample supply of capital makes more extensive livestock production feasible. With an assumed unlimited supply of capital at a constant cost of $0.06 per dollar used, the opportunity cost of purchased grain does not rise above $1.43 per bushel ($1.35 x 1.06 = $1.43). Reference to the first column of Table 16 indicates that purchase of feed grain, when concentrate output is not controlled, is profitable to four of the seven farm situations with unlimited capital supplies.

When concentrate output is controlled, purchased feed grain can be profitably utilized by all unlimited capital farms analyzed, with the exception of farm no. 19, the 330-acre northern Iowa farm. The 330-acre farm is exceptionally large, both in terms of crop acreage and feed supply, for a one-man labor supply. Labor that remains after crop production is sufficient for only a relative small livestock enterprise that uses about one-fourth of the supply of feed grain. Even with a reduction of as much as 40 percent in concentrate output, grain supply is approximately twice as large as grain consumption, and nearly 4500 bushels of corn are sold.

The farms with an unlimited capital supply have the capability of buying in the market a quantity of feed grain equal to the amount by which feed grain output is reduced under controls. If increased purchases exactly counter-balanced reduced output, livestock production could be continued under controls at exactly the same level as was profitable when there were no controls on concentrate output. However, the irregular relation between feed grain purchases and percentage reduction in concentrate output indicates that such a response is not made when profits are maximized. For example, farm no. 2 (a 240-acre, average, one-man southern Iowa farm) shows a decrease in feed purchased to be profitable as the reduction in concentrate output increases from 10 percent to 20 percent. The changes in feed grain production and purchases, as concentrate output is reduced on this farm are shown in Table 17.

Part of the irregularity in the interrelations of concentrate output reductions, feed grain production and feed grain purchases is due to substitution between soybean production and corn production. A more important factor in

Table 17. Changes in feed grain production and purchases as related to changes in concentrate output on the 240-acre, average, one-man, unlimited capital farming situation

Reduction in concentrate output	Concentrate output	Change in feed grain	
		Production	Purchases
From 0 to 10 percent	-330	-327 bu.	536 bu.
From 10 to 20 percent	-330	-173 bu.	-521 bu.
From 20 to 40 percent	-660	-751 bu.	592 bu.

variations of feed grain purchases is adjustments in livestock production, to make profitable use of resources diverted by output control from the production of grain crops.

Policy implications

The assumed model for individual farming situations leads to an estimate of considerable increase in net grain purchases over grain sales as concentrate output is controlled. If realized in actual operation, such a response would reduce surplus accumulations and perhaps provide an opportunity for disposing of some of currently held surplus stocks. Total impact of a nationwide program comparable to the one assumed here for a small area would depend upon response in a large number of other producing areas not a part of this investigation. Also, evaluation of the validity of the assumed market price would be dependent upon estimation in a nationwide model of grain sales and purchases.

Substitution of Other Products (in Total) for Feed Concentrates

The interrelation of output of all other products in total and output of feed concentrates provides a summary view of the substitutions discussed above. To calculate this relation, outputs of all products were valued on the basis of the high assumed prices. Concentrate output is valued at market price whether sold or used as feed on the farm. The value of other products is on a "value-added" basis. It is calculated by subtracting from total value of livestock output the value of livestock purchased and feed fed. Also included in other products is the value of soybean production above its feed value.

Illustrative production possibility frontiers

Production possibility frontiers presented in Figures 2 and 3 show possible combinations of output of other products and output of feed concentrates in two of the representative farming situations. The production possibility frontiers are derived from the profit maximizing plans of linear programming analyses. In the linear programming analyses quantity of variable costs changes with the level of concentrate output, thus violating the assumption of a constant quantity of resources implied in the construction of a production possibility frontier. To correct for this inconsistency, two additional curves were constructed assuming that increased variable costs represent a reduction in output of other products and decreased variable costs represent an addition to other products. These corrected production possibility curves are shown as dashed lines in Figure 2 and Figure 3.

Figure 2 illustrates the case of competition between the output of feed concentrates and other products. It is derived from the analysis of farm no. 5, representative of a 480-acre, average, two-man unlimited capital farm in southern Iowa. When resources are forced out of the production of feed concentrates, forage production and livestock production are increased, offsetting in part the reduction due to control of feed concentrate. Of critical importance is the opportunity to invest additional capital in expanded beef cattle production.

Figure 3 illustrates the case of complementarity between the outputs of feed concentrates and other products. Value output of other products is complementary almost throughout the entire range of concentrates outputs. When corrected for changes in variable costs, the range of complementarity is shortened but it remains important. Figure 3 is derived from the analysis of farm no. 1, representative of a 240-acre, average, one-man, intermediate capital farm in southern Iowa. The complementary relation in this farming situation arises from the restricted capital

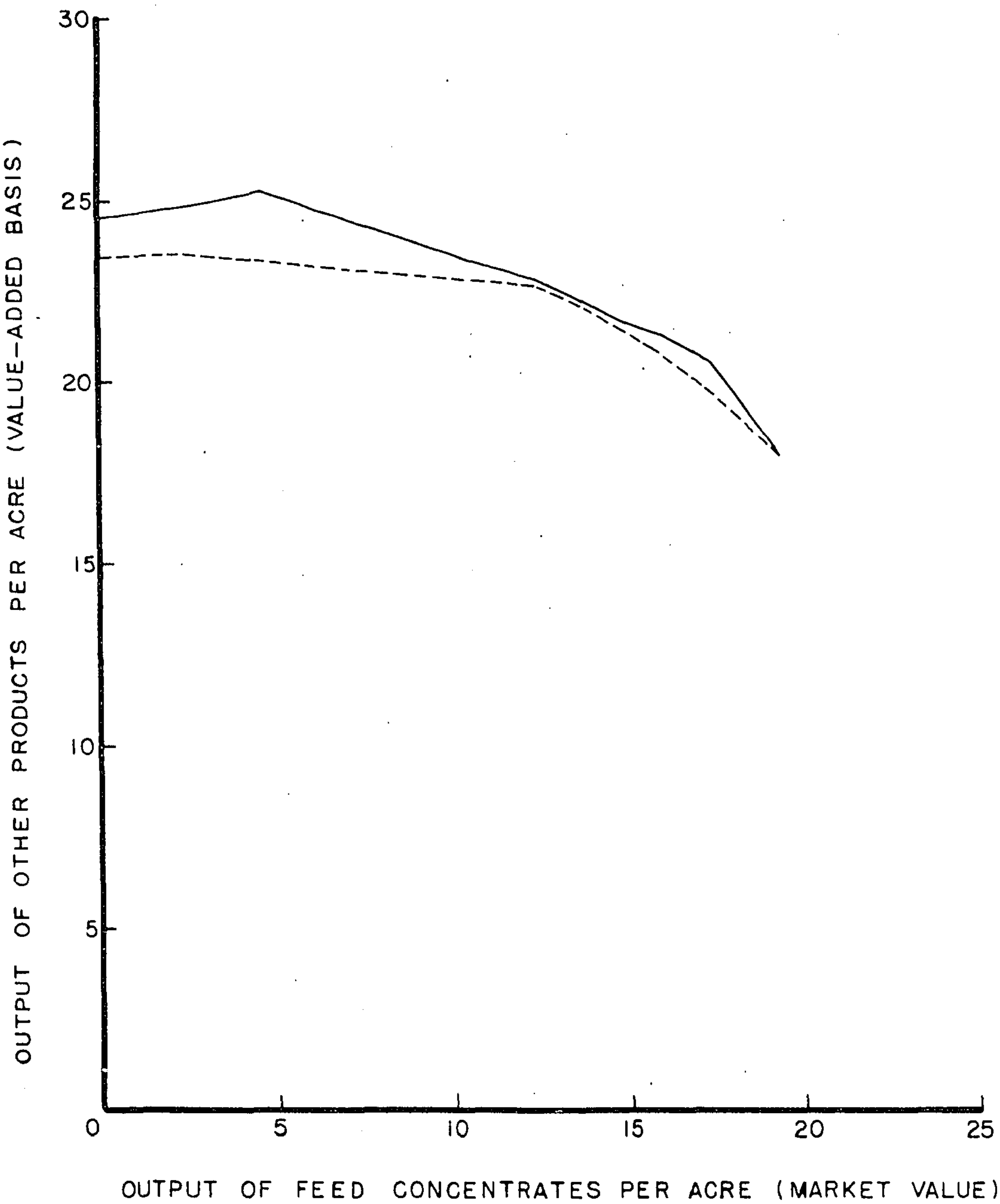

Figure 2. Output of other products as related to output of feed concentrates on farm no. 5

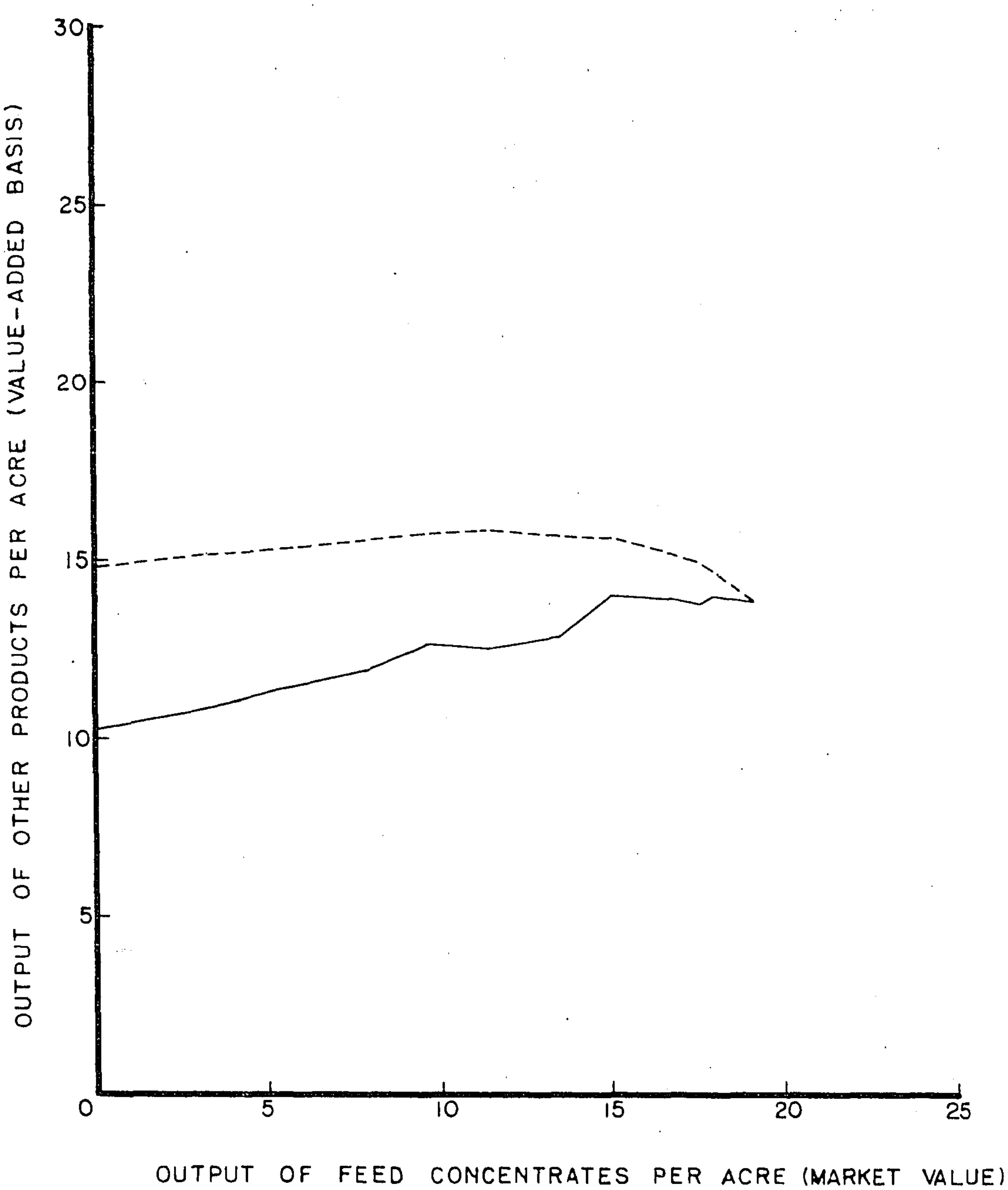

Figure 3. Output of other products as related to output of feed concentrates on the bench-mark farm (farm no. 1)

supply. As feed concentrate output is reduced, grain-consuming livestock enterprises must be curtailed. The loss in value is greater than just the loss of the value of the grain, and unlike farm no. 5 (Figure 2) capital is not available to expand cattle enterprises and provide a market for expanding forage production.

Individual farming situations

Substitution of other products, in total, for feed concentrates is shown in Table 20 (see p. 128 below) for all representative farming situations at a 20 percent reduction in feed concentrate output. In each case the value given in Table 20 is change from the uncontrolled profit maximizing plan. No adjustment was made for changes in variable costs. The value of other products are calculated according to the procedure given above.

Complementarity between output of feed concentrates and output of other products is indicated by negative values for farms no. 7, 10, 11, 12 and 14. Particularly sizeable substitutions of increased output in other products as feed concentrate output is reduced are found for farms no. 5, 13, 15, 17 and 19. All farms with sizeable substitution are unlimited capital farms.

Policy implications

The magnitude of change in output of other products as output of feed concentrate is reduced indicates the extent to which control fails to achieve an equivalent reduction in total farm output. A large increase in output of other products indicates that the final effects of output control in feed concentrates will be partially offset by diversion to other products. A decrease in output of other products as feed concentrate is reduced indicates that output control in feed concentrates will have an augmented effect on total farm output.

The effect of direct control over feed concentrate output, as evaluated in this study, is partially offset by increased output of other products. Total value of agricultural production is reduced by an average of 28 percent less than the value of 20 percent reduction in concentrate output (both at constant prices). The effect of output control on price will be somewhat less than if output control brought with it a reduction in net farm output equal to the value of the reduction in concentrate output.

EFFECT OF OUTPUT CONTROL ON RESOURCE USE

A reduction in the total amount of resources employed in agricultural production is a possible result of output control. When output is restricted, it may be possible to produce the maximum permitted output using fewer resources than were employed to produce the output that maximizes income with no controls on output. It may be profitable to produce less than maximum output possible within the limitations of the output control. If marginal cost exceeds the value of the marginal unit of output a reduction in resources used (cost incurred) and in output will increase net revenue.

It is only possible to reduce costs that are variable for the planning period. In this study a short-run planning period was assumed in which family labor, machinery and equipment, and buildings and land are assumed to be in fixed supply to the firm. Within the assumptions of the model used no reduction in costs can be attained in the short-run by reducing the use of the fixed resources. However, some inferences may be made from the results of the short-run analyses as to adjustments which will be likely in the long run.

Changes in Variable Costs in Response of Output Control

As a general rule, control of concentrate output opens the possibility for individual producers to reduce total variable costs. In the aggregated model for the southern Iowa farming situations the weighted average expenditure per farm for variable costs was

No controls	$1,560
10% reduction	1,233
20% reduction	1,117
40% reduction	1,014.

The cost savings associated with the first 10 percent reduction in concentrate output are 50 percent larger than the total costs savings realized over the 30 percent reduction in concentrate output from a 10 percent reduction to a 40 percent reduction. Thus, major opportunities for cost reductions appear to exist for a small output reduction only. Two important sources of cost savings are: 1. Reduced crop production costs and 2. Decreased expenditures for commercial fertilizer. Changes in amount and type of livestock enterprises also may bring some change in total variable costs.* If expanded livestock production is used as a means of employing resources diverted from crop production, then variable costs may be increased as output of concentrates is reduced.

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*The accounting used in this study considers feed and livestock purchased to be goods in process rather than variable costs. Feed and livestock purchases reduce net output, on a value added basis, to less than total output but do not increase variable costs.

Crop costs

Intertilled crops require more variable expenses per acre than do grain and forage crops. The effect of concentrate output control on crop acreages has been discussed in detail above (see Tables 9 and 11). A reduction in intertilled and harvested crop acreages is found in all farming situations. A reduced acreage of crops harvested gives the greatest cost savings. The reduced acreage harvested may be reflected either in additional cropland used for pasture or cropland not harvested and not pastured.

Expenditures for commercial fertilizer

The findings of this study indicate that a decrease in expenditures for commercial fertilizer is profitable when output of feed concentrates is reduced by direct control. The weighted average of expenditures for commercial fertilizer in the southern Iowa farming situations with no controls and with 10, 20 and 40 percent reduction in concentrate output were:

No controls	$158
10% reduction	36
20% reduction	29
40% reduction	15.

Most of the decrease in expenditures for commercial fertilizer takes place with a reduction in concentrate output of 10 percent or less. A similar reduction in expenditures for commercial fertilizer was found to be profitable for the northern Iowa farming situations (see Tables 51 to 54).

The decrease in expenditures for commercial fertilizer arises from two sources. First, a reduction in amount of fertilizer required to maintain the same general level of fertility follows as land is shifted from corn production. Other crops require less than does corn. Cropland not harvested or pastured requires none. Second, some reduction in the rate of fertilizer application may be profitable when output control makes it no longer possible to produce grain at or near the maximum consistent with soil conservation. On class III southern Iowa land the rate of return is $1.33 per dollar spent on commercial fertilizer applied to a six-year corn-corn-oats-meadow-meadow-meadow rotation. Farming situations that have only limited capital funds usually show decreased fertilization on this land to be a profitable response to output control. Capital may be employed in other uses for a higher return per dollar invested. With limited capital funds, livestock production to use all forages is not possible. Therefore, the use of more land, at a lower fertilization rate, to produce the same amount of grain does not compete with other profitable uses of land.

A finding of decreased fertilization in response to output control seems to disagree with the commonly held opinion that an effect of output control has been increased fertilization. But this claim is made with reference to a program of control over crop acreages that does not control other inputs or outputs per acre. Under certain circumstances (increased ratio of product price to cost of commercial fertilizer, availability of capital funds that were formerly used for seed and machinery costs on a larger acreage, or some as yet unexplained reason for farmers fertilizing at less than the optimum rate to increase fertilization when acreage is controlled) increased fertilization may be a profitable response to acreage restrictions. However, when control is applied directly to output, as was assumed in this study, there is no possibility to substitute fertilizer for other inputs as a means of maintaining or increasing feed concentrate output.

Policy implications

The results of this study indicate that typical Iowa farms maximizing profits will use less variable costs per farm when output of concentrates is reduced than when there are no controls on output. A reduction in variable costs is desirable from the standpoint of efficiency (in this case, minimum resource use for a given output). A reduction in variable costs in response to output control also means that the ultimate goal of increasing incomes of agricultural producers will be achieved with less transfer of income from other sectors of the economy.

Reductions in variable costs to farmers imply reduction in sales to industries that supply goods used in agricultural production. The results of this analysis indicate that direct control over feed concentrate output would lead to a noticeable reduction in fertilizer inputs.

Effect of Output Control on Allocation of Fixed Resources

The model that was used in this study to derive profit maximizing response to control over feed concentrate output is based upon the assumption that there is no feasible opportunity for the individual farmer-entrepreneur to either buy or sell land, labor or machinery. The supplies of these resources are fixed at their initial quantities for the assumed short-run adjustment period.

If a control program continued for a long period of time, a part of its effect would be to bring about some adjustment in use of resources that are fixed in supply during the short-run period. Resources with alternative uses might be shifted to or from off-farm employments. Resources committed to agriculture might be reallocated among farms. Although the model used does not permit definitive statements as to the reallocations which would be likely to occur, some inference as to probable long-run adjustments may be drawn from examination of the value productivities imputed to fixed resources in the short-run model.

When a resource has an imputed value productivity to some firm that is greater than the cost of acquiring the resource (i.e., its productivity to other firms) and this situation is expected to continue, the firm may increase expected profits by increasing its holdings of the resource. Conversely, an imputed value productivity that is lower than the market rate for the resource indicates that the firm may increase income by decreasing its holdings of the resource. When resources are available to the firm but not used in a production plan that maximizes income, it may be inferred that an entrepreneur who is maximizing profits would be willing to lease or sell the unused resources for any positive return.

The marginal value productivities of farms' fixed resources are, in general, reduced by control of feed concentrate output when the same expected prices apply in each case. First, output control reduces the income earning capabilities of the farms' fixed resources (including operators' labor and management). The reduced income is, in turn, reflected into reduced marginal value productivities of resources. Second, output control introduces quotas or production permits as a new and separate pseudo-resource which is an essential element in the income earning efforts of the farm firm. As an essential element in production, quota has a marginal value productivity which is equal to the increase in income, all other things remaining equal, which is possible with the possession of one additional unit of quota. Some value of output that would otherwise be imputed to ordinary factors of production will instead be imputed as returns to quota.

A comparison of marginal productivities based on the assumption of constant prices is not necessarily indicative of long-run resource adjustments in response to output control. An important part of the effect of output control is a price rise due to aggregate effects on market supplies. Incomes and thus marginal value productivities will differ with price changes even though output is unchanged. Imputed marginal value productivities under the high assumed prices were adjusted to give approximations to marginal value productivities under projected 1961 prices as follows:

$$MVP_{1961} = MVP_{high} \frac{\text{Net farm income}_{1961}}{\text{Net farm income}_{high}} .$$

Subscripts denote the prices that apply.

The impact of output control on the marginal value productivity of fixed resources varies between resources within a given firm and between firms using a given resource. The primary impact of output control is on the value productivity of land since imposition of quotas amounts to a separation of some of the rights normally associated with the ownership of land.

Land

There is no significant demand for farmland for non-farm uses in either of the study areas. Therefore, reallocation of land in the event of long-run production control must be confined to exchanges among farmers. Profit maximization dictates that exchange take place from farms where land has a low marginal value productivity to farms where it has a high marginal value productivity. Differences in marginal value productivity may persist for a considerable period of time before adjustment in the distribution of land actually takes place. However, the direction of transfer in the long run will be indicated by differences in marginal value productivity.

The imputed marginal value productivity (annual) of an acre of farmland is given in Table 18 for the representative farming situations. The imputed productivities in Table 18 apply to an average acre of farmland containing cropland by classes, pastureland and wasteland in the proportion that they occur on ~~the~~ average in the area. The imputed productivity of an average composite acre is calculated for each farm by weighting the imputed productivities of cropland by classes and pastureland in proportion that they occur on the average throughout the area. Adjusting all imputed productivities to the basis of an acre of average land makes possible direct comparisons among southern Iowa farming situations having different soils in different proportions.

In the first column of Table 18, the marginal value

Table 18. Imputed marginal value productivity of an additional acre of average farmland (a) with no controls under two alternative price assumptions and (b) with 20 percent reduction in concentrate output and two alternative assumptions regarding combination of quota with land

Farm no.	No controls		20% reduction in output	
	High prices	1961 prices	Land without quota	Land and quota combined
Southern Iowa				
1	$13.61	$11.21	$ 1.01	$14.70
2	26.84	23.89	16.20	24.84
3	13.61	10.28	2.82	10.86
4	6.89	5.35	3.22	7.75
5	26.80	25.84	18.30	24.65
6	10.10	7.99	3.45	9.85
7	23.37	19.70	10.28	19.24
8	12.84	9.41	2.68	11.53
9	12.81	10.56	1.63	13.22
10	19.52	15.93	7.01	17.58
11	17.69	14.86	1.93	15.45
12	27.36	24.05	16.39	27.57
13	26.31	22.36	15.27	26.33
14	16.99	14.03	1.47	15.11
15	21.63	18.90	11.61	21.32
Northern Iowa				
16	44.97	33.32	14.88	40.30
17	49.33	40.50	37.58	52.97
18	39.72	29.04	9.42	37.74
19	36.28	27.28	22.22	36.25

productivity of land is given as derived from the linear programming analyses. The high assumed prices apply. In the second column, marginal value productivities are given as adjusted to conform to incomes with prices at the projected 1961 prices. The procedure listed above was used to adjust the imputed productivities. The imputed productivities with 1961 prices give an estimate of the present situation. There is considerable variation of productivities among farms in the southern Iowa area. The range is from \$5.35 to \$25.84 per acre (farm no. 4, a 240-acre, average, part-time, intermediate capital farm and farm no. 5, a 480-acre, average, two-man, unlimited capital farm). The highest marginal value productivities for land are found on farms with unlimited capital.

The annual cost for interest (at 6 percent per year) and taxes on land at the average value reported in the U.S. Census of Agriculture (61) is \$9.41 for southern Iowa and \$21.02 for northern Iowa. The marginal value productivity of land, assuming 1961 prices, is above the annual cost for all farming situations except farms no. 4, 6, and 8.

Imposition of a 20 percent reduction in feed concentrate output causes a sizeable decline in the imputed value productivity of land without quota (see the third column of Table 25). Amount of capital available is an important determinant of the magnitude of the decline. Farms with an unlimited capital supply characteristically show a decline of about one-third in the imputed value of additional land. Farms with limited capital characteristically show a decline almost to zero in the value productivity of additional land without quota for producing feed concentrates. Exceptions to this very low marginal value productivity are found on farms no. 7 and no. 10, both of which have very small crop acreage (72 and 83 acres respectively), and farms no. 16 and no. 18, both of which are northern Iowa cash grain farms with wide lattitude for substituting soybeans into the cropping program and continuing full use of land in spite of reductions in concentrate output.

Quota or permits to produce feed concentrates also have imputed value productivity. Although not necessarily directly tied to the land, quotas will be closely associated with land. If the value of quotas is added to the imputed value of land the resulting value for land and quota combined is comparable to the value productivity of land alone with 1961 prices and no controls on output. The imputed value productivity of land and quota, taken with a 20 percent reduction in output and associated rise in prices is higher for all farms except two that show slightly reduced values (farms no. 5 and 7). Among the southern Iowa farming situations there does not appear to be any pattern in the relative magnitudes of the change in imputed productivity. The value of additional land to northern Iowa farming situations is increased by a 20 percent reduction in concentrate output and the associated price increase by about the same proportion of 1961 value as southern Iowa farms were.

Labor

Farmers' labor is a partially mobile resource with more opportunities for reallocation than agricultural land. The labor of older farmers and individuals with strong personal preferences for agricultural employment is generally not mobile. However, high outmigrations from agriculture indicate that many persons employed in agriculture are responsive to differentials between returns in agriculture and returns in other employments (31, p. 163).

Either a decrease in the number of hours worked per farm or a decrease in the marginal value productivity of labor would indicate a possible increase in the tendency to take off-farm employment (assuming no change in the off-farm wage rate and employment opportunities). As output of concentrates is reduced, both of these changes occur in representative farming situations. However, on seven out of nineteen farming situation changes of the opposite direction (i.e. increases in the number of hours worked or increases in the imputed marginal value productivity of labor) occur. Thus, it cannot be said that a 20 percent reduction in feed concentrate output will contribute much to facilitating labor transfer from agricultural employment to non-farm employment.

Some evidence of a possible tendency for direct controls of feed concentrate output to encourage part-time farming may be gleaned from a comparison of labor management returns and amount of labor used in farming situations no. 1 and no. 4. Both of these farming situations represent 240-acre, average southern Iowa farms with intermediate capital supplies. Farm no. 1 has a one-man labor supply (2700 hours) and farm no. 4 has a part-time labor supply (1000 hours). The differences between incomes and amount of labor used on these two farms are:

	Difference (full-time farm minus part-time farm)	
	Income	Labor used
No controls	$962	1262 hrs.
10% reduction	899	1049
20% reduction	625	968
40% reduction	190	700

The one-man and part-time farms become more similar both with respect to amount of income and with respect to amount of labor used as output of concentrates is reduced. If an opportunity exists to accept a non-farm job and continue farming on a part-time basis, the full-time farmer may be more likely to accept the position when output of concentrates is controlled than when he is free to produce with no controls.

Capital

Use of operating capital would apparently be little affected by the imposition of a control upon feed concentrate output. Farming situations that were permitted the option of unlimited use of capital at a constant opportunity cost of $0.06 per year per dollar used generally indicated that it would be profitable to expand slightly the use of operating capital when concentrate output is controlled. Additional capital is invested to increase beef production, which requires more capital investment per dollar of output than do hogs, and to increase purchases of feed grain. Capital-using changes more than offset some capital savings through decreased expenditures for commercial fertilizer and other crop costs.

Profit maximizing plans for farming situations with a limited capital supply showed no sizeable changes in the imputed marginal value productivity of capital under the impact of control on the output of feed concentrates. Farming situations showing slightly decreased marginal value productivity of capital were in part offset by other farming situations with increased productivity. In no case did the marginal value productivity of capital fall below the interest rate; therefore, it would be expected that those farms with limited operating capital would continue to use capital to the limit of available funds.

Changes in Total Resource Use

Total value of resources used per dollar of output produced provides an indication of efficiency in resource use. Average total cost per dollar of final output produced is shown in Table 19 for all representative farming situations at alternative levels of output control. Total cost includes both variable and fixed costs. A charge for labor was included at the rate of $1000 for a part-time operator,

Table 19. Average total costs per dollar of net farm output with no controls and with 10, 20 and 40 percent reductions in concentrate output as estimated by profit maximizing plans for representative farms

Farm number[a]	No controls	Reduction of 10%	Reduction of 20%	Reduction of 40%
1	$1.06	$1.08	$1.14	$1.32
2	0.96	0.97	0.99	1.08
3	1.22	1.25	1.30	1.47
4	1.07	1.09	1.11	1.20
5	0.90	0.91	0.92	0.99
6	0.93	0.94	0.96	1.07
7	1.25	1.28	1.32	1.48
8	1.09	1.12	1.18	1.41
9	0.96	0.97	1.02	1.20
10	1.27	1.31	1.36	1.49
11	1.04	1.07	1.11	1.22
12	1.20	1.22	1.23	1.31
13	0.99	0.99	1.00	1.07
14	1.32	1.36	1.42	1.59
15	1.20	1.22	1.26	1.30
16	0.92	0.93	0.99	1.17
17	0.85	0.86	0.88	0.92
18	0.79	0.80	0.84	1.02
19	0.76	0.77	0.78	0.84

[a]Refer to Table 7, p. 40 for a description of farming situations and a listing by numbers.

and $2000 for one man and unpaid family labor. Average total costs are greater than unity for several of the farming situations, indicating that returns are not great enough to cover both variable and fixed costs and provide a return to labor as large as the assumed value.

The results presented in Table 19 show that for all farming situations analyzed average total costs increase as output of feed concentrates is reduced. The special restraint (specification of concentrate output) imposed on total farm production may be a factor in causing average costs to rise as output of concentrates is reduced.

Policy implications

Reductions in variable costs result from profit maximizing response to output control. However, cost reductions are not adequate to prevent an increase in average cost per dollar of net farm output. Therefore, under production control as applied in this study, resource use per dollar of farm products produced is greater than when output is not controlled. Efficient use of resources is not furthered by the production control. Relaxing the restraint on adjustments in amount of land, labor and capital could lead to further reductions in total resource use in agriculture. However, the indicated limited contribution of production control to fostering reduced use of fixed resources would probably not be adequate to bring about much improvement in the effects of output control on quantity of resources used.

EFFECT OF OUTPUT CONTROL ON INCOME - ALTERNATIVE METHODS OF OBTAINING PARTICIPATION

From the viewpoint of the individual producer who is selling his product in a competitive market, an output reduction means a loss from income that could potentially be received from an uncontrolled output marketed at the same prices. Individual producers may be induced to participate in a program imposing collectively mandatory reductions on all producers in the expectation of increasing incomes to all producers through the effect of a reduced output upon market price. Voluntary participation on an individual basis can be achieved only if producers are adequately compensated for expected income losses due to control of output.

Effect of Output Control on Farm Income - Prices Constant

Substitution of other products and reductions in variable costs make it possible for producers to avoid part of the impact of a reduction in concentrate output. However, the opportunities to avoid the income reducing effects of output control by these means are always less than complete. Some income loss remains as long as the producer considers that any price increase is independent of his own actions.

The effect of a reduction in concentrate output on farm income is shown in Table 20. The initial impact of output control on income is defined as the market value of the

Table 20. Effect of output control on net farm income - initial impact, product substitution, cost reductions and net income loss for representative farming situations at a 20 percent reduction in concentrate output as estimated by profit maximizing farm plans

Farm number	Initial impact	Product substitutions	Cost reductions	Net income loss[a]	
				per farm	per feed unit
1[b]	-$ 918	$ 63	$ 345	-$ 510	-$0.70
2	- 820	195	312	- 313	- 0.48
3	- 923	177	466	- 280	- 0.38
4	- 850	377	300	- 173	- 0.26
5	-1,860	1,659	- 181	- 382	- 0.26
6	-1,875	678	669	- 528	- 0.35
7	- 408	- 42	277	- 173	- 0.53
8	-1,573	384	602	- 587	- 0.47
9	-1,570	87	761	- 722	- 0.58
10	- 402	- 186	344	- 244	- 0.76
11	- 820	- 211	505	- 526	- 0.80
12	- 382	- 27	287	- 122	- 0.65
13	- 785	788	- 152	- 149	- 0.24
14	- 402	- 78	171	- 309	- 0.96
15	- 402	198	- 25	- 229	- 0.71
16	-1,830	459	659	- 712	- 0.49
17	-1,710	1,343	- 68	- 435	- 0.32
18	-3,842	1,318	970	-1,554	- 0.51
19	-3,808	2,168	740	- 900	- 0.33

[a]Net income loss is the algebraic sum of initial impact and countereffects. The negative sign is retained for clarity within the table.

[b]Refer to Table 7, p. 40 for a description of farming situations by farm numbers.

reduction in feed concentrate output. All feed concentrates produced, including the feed value of soybeans, are valued at $1.25 per feed unit. The initial impact of a 20 percent reduction in output on income is shown for all representative farms in the first column of Table 20.

Increased production of substitute products that are not subject to output control and reduced variable costs each serve to partially counteract the initial impact of a reduction in concentrate output. Substitution and cost savings have been discussed in detail above. They are presented in the second and third columns of Table 20.

Net income loss is presented in the fourth and fifth columns of Table 20 on a per farm and per bushel basis. The average (weighted by the aggregation model) loss in the southern Iowa farming situations was $312 per farm and $0.50 per feed unit. Average income loss is thus equal to 40 percent of the market value of the reduction in production. The average loss was not computed for the northern Iowa farming situations. It would be less than the average for the southern Iowa farms. The cash grain farms (farms no. 16 and 18) incur an average loss per feed unit that is approximately equal to the average of the southern Iowa farms. But, income loss per feed unit is only $0.32 and $0.33 on the northern Iowa farms with unlimited capital.

Mandatory Output Reductions Compensated by a Price Rise

Mandatory output reductions have been used as a means of attaining higher prices and higher incomes. Although no producer can act individually in the expectation of price increases as a result of his own output reduction, all producers can act collectively to impose output restrictions on themselves in the expectation of receiving higher product prices and thus higher incomes.

The possibility of attaining greater producer incomes through production control is a well known property of markets with price inelastic demand functions. The demand for feed concentrates is price inelastic. Therefore, for the average of all producers and for most individual producers an increase in income would be the expected outcome of effective supply control.

However, individual producers' incomes would be changed by varying amounts, depending upon their particular resource situation and pre-control product mix. Some producers might have a greater decrease in income due to output production than increase due to price increases. However, on balance, most producers would gain.

Price-output substitution in the bench-mark farm

As an example, the substitution between general level of product prices and concentrate output are shown in Figure 4 for the bench-mark southern Iowa farm (farm no. 1, a 240-acre, average, one-man, intermediate capital farm). Iso-income lines on this graph show price-output combinations that yield the same net farm income. Incomes at

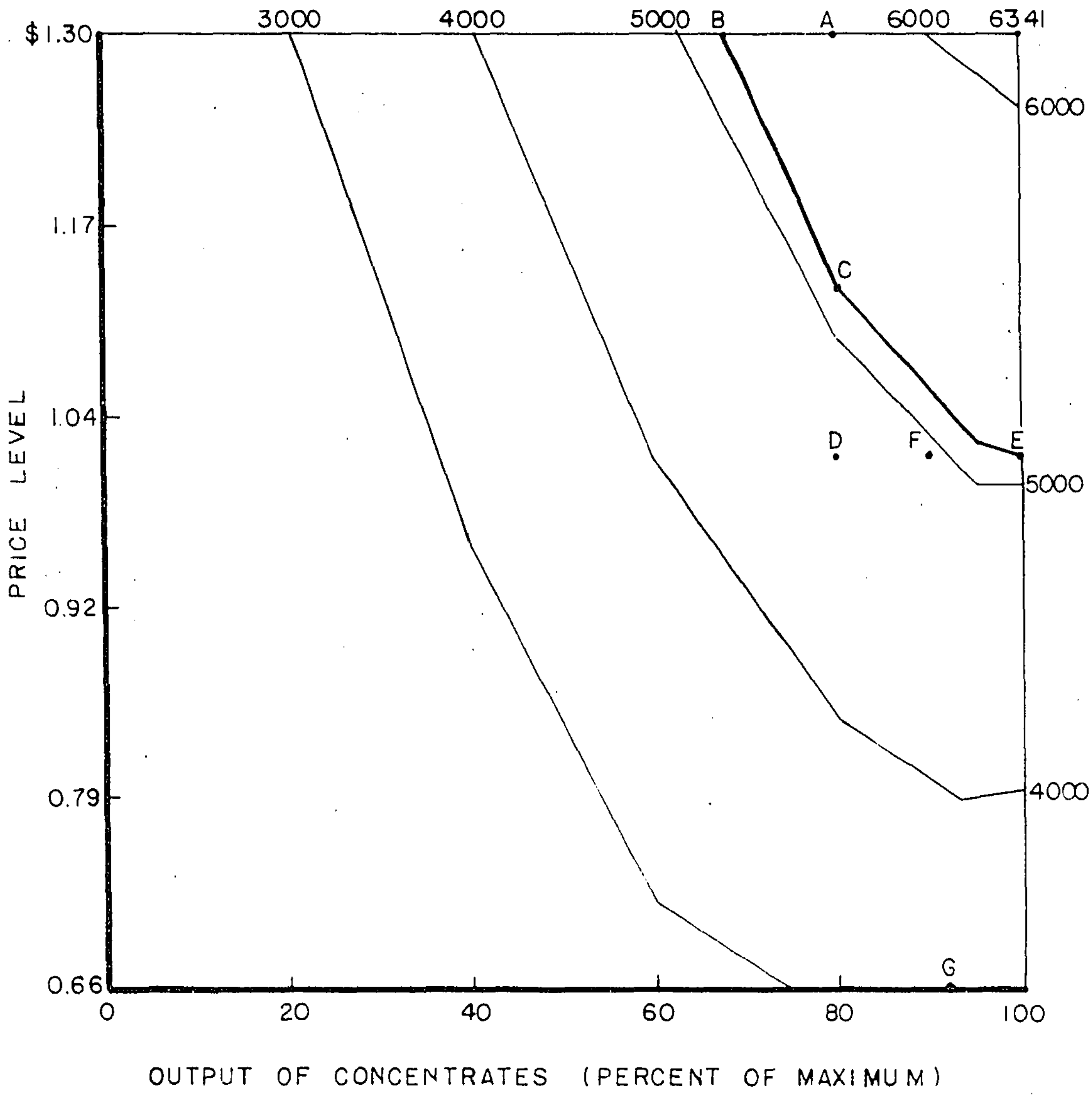

Figure 4. Substitution between price level and output of concentrates as a source of income for the bench-mark farm (farm no. 1)

alternative price levels* with unrestricted outputs and at alternative output levels with the high assumed prices were derived by parametric programming. These two sets of solutions determine positions on the borders of the graph. Incomes for intermediate combinations of price level and grain output were obtained by estimating change in income per unit change in price at several alternative levels of grain output.

Net income for the bench-mark farm with unrestricted output is $5,143 when evaluated at 1961 prices. The $5,143 iso-income curve is shown by the heavy line across the upper-right-hand quadrant of Figure 4. All price-output combinations above and to the right of the $5,143 iso-income curve represent higher incomes. Points below and to the left represent lower incomes.

A choice of prices is not normally available to an individual producer in a competitive market. The prevailing price applies for all possible levels of output. In terms of Figure 4 the producer's profit maximizing choice of outputs is given by the intersection of a horizontal line at the prevailing market price level and the highest iso-income curve touched by the price line. However, under a system of production controls, the producer may have some choice as to the price and output level at which he operates.

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*Prices are shown in terms of the price of corn as an index of all product prices.

Four hypothetical program alternatives are represented in Figure 4 by the price-output combinations at points A, E, F and G. These points conform to price-output combinations as follows:

A. Twenty percent reduction in concentrate output and prices consistent with corn at $1.30 per bushel.

E. Uncontrolled output and projected 1961 prices.

F. Ten percent reduction in output and prices consistent with corn at $1.00 per bushel.

G. Uncontrolled output and projected free market prices.

Points A, F, and G are consistent with aggregate (national) market clearing price-output combinations as outlined above (pp. 14-16). Point E represents an uncontrolled output and projected 1961 prices. Prices at point E reflect, implicitly, price support through non-recourse loans and through the output reducing effects of a 27 million-acre conservation reserve.

As a source of income, the producer is considered to be indifferent between price-output combinations that give equal incomes. If prices are expected to rise with output control more rapidly than is necessary to maintain income (remain on the same iso-income curve) then it is to the advantage of the producer to have a program of output control in operation.

Incomes on the bench-mark farms under the four alternatives are:

A.	$5,731
B.	5,143
F.	5,033
G.	3,054.

Point A yields the highest income to the bench-mark farm of any of the four alternatives. Therefore, if choosing between alternative outputs and consistent prices, the operator of a farm of this type would maximize profits by choosing a reduction in output of 20 percent. Both point F and point G yield inferior incomes to the present earning. Therefore, if permitted, the present program would be continued in preference to either F or G.

Individual farming situations

The net income change due to participation in a program involving a 20 percent reduction from uncontrolled concentrate output is shown in Table 21 for all representative farming situations. The net income change reflects both the income lost from a reduction in output and the benefit of a price rise. The net change is positive for all situations analyzed in this study. If given the alternatives of present prices and an uncontrolled output or a 20 percent reduction in concentrate output and the high assumed prices, all profit maximizing producers would choose the latter.

The net effect of a 20-percent output reduction and 30-percent price rise upon income varies considerably from one farm situation to another. Primarily this variation

Table 21. Income loss due to a 20 percent reduction in output, gain due to associated price increase and net gain accounting for both output and price effects for representative farms as estimated by profit maximizing farm plans

Farm number[a]	Income loss due to output control	Income gain due to price increase	Net change due to output and price
1	-$510	$1,098	$ 588
2	- 313	1,116	803
3	- 280	1,062	782
4	- 173	1,080	907
5	- 382	2,371	1,989
6	- 528	2,421	1,893
7	- 173	498	325
8	- 587	1,961	1,374
9	- 722	1,560	838
10	- 244	736	492
11	- 526	1,243	717
12	- 122	855	733
13	- 149	1,176	1,027
14	- 309	675	366
15	- 229	496	267
16	- 712	2,187	1,475
17	- 435	1,784	1,349
18	-1,554	4,522	2,968
19	- 999	4,408	3,409

[a]Refer to Table 7, p. 40 for a description of farming situations by farm number.

is due to difference in the over-all scale of operation. However, there are some differences due to the type of farming situation. The price of grain tends to rise relatively more than the price of other products since the initial impact of the program is upon grain production and only a secondary impact falls upon output of other products. Farm situations in which a large proportion of the grain produced is sold rather than fed to livestock gain proportionately more in income from the effects of the program.

In Table 22 the average net income gain due to the program, as a percentage of base income evaluated at 1961 prices is shown for the representative situations grouped as grain selling or grain feeding farms. Grain selling farms include all farms selling at least 10 percent of their grain production. Four representative grain selling farms from among the southern Iowa situations would realize, under program conditions, an average increase of 23 percent in net income. Grain feeding farms on the other hand would realize an average increase of 13 percent or only about 56 percent as much as the grain selling farms. All four northern Iowa farm situations were classified as grain selling farms. The average increase in income for the northern Iowa farm situations is 23 percent.

Table 22. Net gain due to 20 percent output control per dollar of base incomes - simple average for typical farm situations by area and by grain sales

Farm situations	Number of situations	Average net gain per dollar of income
Southern Iowa grain-selling farms[a]	4	.23
Southern Iowa grain-feeding farms[b]	11	.13
Southern Iowa farms	15	.16
Northern Iowa grain-selling farms	4	.23

[a]Farms no. 3, 4, 6 and 8.

[b]All farms not grain selling farms.

Voluntary Output Reductions with Compensation for Average Income Loss

As an alternative formulation of an output control program, assume that a policy decision has been reached regarding the price goal for agricultural products and the method that is to be used to achieve these prices. The price goal is the high assumed prices described above and the method by which these prices are to be achieved is a 20 percent reduction in feed concentrate output on all farms. Further assume that participation by producers in the program of output reduction is to be voluntary. Each producer will be free to choose between participating and not participating on the basis of his own estimates of relative net returns under the two alternatives. The problem in program formulation is to devise a scheme of compensation for income losses due to reduced output that will make it profitable for producers to participate in the proposed output reduction.

Participation is to be voluntary, and the aggregate price goal is to be achieved in the market. Therefore, each producer will consider that his alternative output possibilities, uncontrolled output and output with a 20 percent reduction in feed concentrates, are to be valued at the same price. Compensation must be equal to the difference between incomes from these two alternative outputs. Compensatory payments*, proportionate to the amount of reduction provide the most straightforward method of compensation.

Specifying a common percentage reduction in output for all farms may reduce the amount of government compensation needed to achieve the output reduction. With only one possible level of participation, the individual producer's decision to participate will be based on average income loss (average value of quota) rather than marginal income loss (marginal value of quota). The average value is equal to or less than the marginal value. Therefore, required payment for a given output reduction from an individual farmer will be less when only one amount of output reduction is permitted than when the amount of output reduction may be varied by small increments.

If the reduction in output is organized on the basis of a proportionate reduction by all producers, then 100 percent participation and the full reduction in output can only be achieved by setting a compensation rate that is equal to the highest average income loss among all farms. Among the representative farming situations used in this

*Compensatory payments have been used in the Acreage Reserve of the Soil Bank in 1956-58 and in the 1961 Emergency Feed Grain Program. In both cases the payments were made on a per acre basis but were computed for each acre on the basis of estimated normal yields. Price incentives were used in combination with the compensatory payments in both programs.

study the highest average incomes loss per bushel reduction in feed concentrate output is found in farm no. 14, a 240-acre rough farm with intermediate capital supply and a restriction against using beef cattle fattening enterprises in the profit maximizing plan. The average loss of income on farm no. 14 is $0.96 per feed unit or 77 percent of the market value of a bushel of corn ($1.25 per bushel). There is a sizeable difference between the compensatory payment required for this farming situation and the payment required for the farming situations with the lowest average income losses per feed unit reduction in output. Income loss for farm no. 5 (a 480-acre, average, two-man, unlimited capital farm) is only $0.26 per feed unit. If the compensation is at the level necessary to gain participation from all farms, there will be a sizeable excess payment to producers having greater opportunity to substitute other products or reduce costs and avoid much of the impact on income of a reduction in feed concentrate output.

The aggregated model for southern Iowa was used to estimate the payment required to just compensate each producer for income lost due to a 20 percent output reduction. The average was $0.50 per feed unit. Under the assumption that all producers received compensatory payments equal to the payment needed for the producer incurring the greatest loss, the average payment would be equal to $0.96 if farm no. 14 is accepted as representing the maximum payment. Excluding farms no. 14 and 15 from the computation since they are special farming situations and do not enter the aggregated model, would leave farm no. 11 as the farming situation with the maximum income loss--\$0.80 per bushel. The excess compensation per feed unit, depending upon which maximum is accepted, amounts to \$0.46 or \$0.30 respectively.

Over-compensation of some producers for their losses under output control is not necessarily undesirable. It involves transfer of income from the rest of the economy via the federal treasury to agricultural producers. Transfer of income is a short-run objective of agricultural policy. However, a value which appears to be generally held is that the transfer of income should come, to the maximum extent possible, through higher product prices and only to the extent absolutely necessary through government payments. If the value of having compensation come through the market is held strongly, a program paying adequate compensation to gain participation of all producers may be unacceptable. In the last column of Table 23 the proportion of compensatory payments in net income gain under a program of the type outlined above is shown. Compensatory payments are assumed to be at a rate of \$0.80 per feed unit reduction. The proportion of compensatory payment in the total is calculated on the basis of net gain due to price effect

Table 23. Income loss and compensation through price increases and compensatory payments for a 20 percent reduction in feed concentrate output for representative farms as estimated from profit maximizing farm plans

Farm no.[a]	Income loss per bu. due to output control	Net income gain per bu. Due to price increases	Net income gain per bu. Due to compensatory payments	Compensatory payments as a proportion of combined net gain
1	$0.70	$0.80	$0.80	$0.50
2	0.48	1.22	0.80	0.40
3	0.38	1.06	0.80	0.43
4	0.26	1.33	0.80	0.38
5	0.26	1.33	0.80	0.37
6	0.35	1.26	0.80	0.48
7	0.53	1.00	0.80	0.44
8	0.47	1.09	0.80	0.42
9	0.58	.66	0.80	0.54
10	0.76	1.53	0.80	0.34
11	0.80	1.09	0.80	0.42
12	0.65	2.14	0.80	0.25
13	0.24	1.12	0.80	0.33
14	0.96	1.14	0.80	0.41
15	0.71	.83	0.80	0.49
16	0.49	1.00	0.80	0.44
17	0.32	.98	0.80	0.45
18	0.51	.96	0.80	0.45
19	0.33	1.13	0.80	0.42

[a]Refer to Table 7, p. 40 for a description of farming situations by farm number.

and output effect as shown in Table 21 and compensatory payment at $0.80 per feed unit reduction.

Unequal Reductions among Producers - Negotiable Quotas

The existence of differences between farms in the net effect upon income of a given percentage reduction in feed concentrate output is suggestive of possibilities for achieving a net gain to producers through an unequal allocation of the reduction among farms. Allocation of the remaining right to produce after the required reduction is equivalent to allocation of the reduction itself. The criteria for efficient allocation of quota to produce feed concentrates are the same as the criteria for efficient allocation of a resource. Total income will be increased by transferring quota from those firms where it has a low marginal value productivity to those firms where it has a high marginal value productivity. Income will be at a maximum when the marginal value productivity of quota is the same for all firms.

The marginal value productivity of quota is derived from the value of the increment of production that can be obtained only if quota is available. Specific knowledge of the marginal value productivity of a production quota to individual producers may be difficult for program administrators to ascertain. Therefore, as a practical matter, production rights probably could not be assigned on the basis of their marginal value productivities. In addition, the political feasibility of a program assigning quotas in this fashion is doubtful. A suggested alternative solution is to assign negotiable production quotas to producers and permit the operation of a market to reallocate quota among producers in an income maximizing* pattern (13, p. 700 and

*That is income maximizing to farmers within the specified national constraints.

20, pp. 54-57).

A market for production quotas could operate in a manner analogous to the operation of any other market. The initial allocation of quota to producers would most likely be made proportional to the historical output of each producer. In this study it is assumed that the initial allocation is proportional to uncontrolled profit maximizing output and that quotas are valid for one year only. Each producer may either buy or sell quota depending upon whether or not the marginal value productivity of quota to the producer is greater or less than the exchange price.

The marginal value productivity of production quotas was obtained from the linear programming analyses of representative farms. A stepped supply schedule for concentrate production quota on a 240-acre southern Iowa farm (farm no. 1, the bench-mark farm) is shown in Figure 5. Points on this stepped supply function show the marginal value of a unit of production quota as related to reductions from uncontrolled output; that is, to amount that has been given up or supplied to the market.

In the example of Figure 5, a price of \$1.09 per bushel for grain production rights would be equivalent to the marginal value productivity of quota at a 20 percent reduction from the uncontrolled production of the farm. The average value of quota is \$0.75 per feed unit at this same output. If \$1.09 can be received per feed unit the

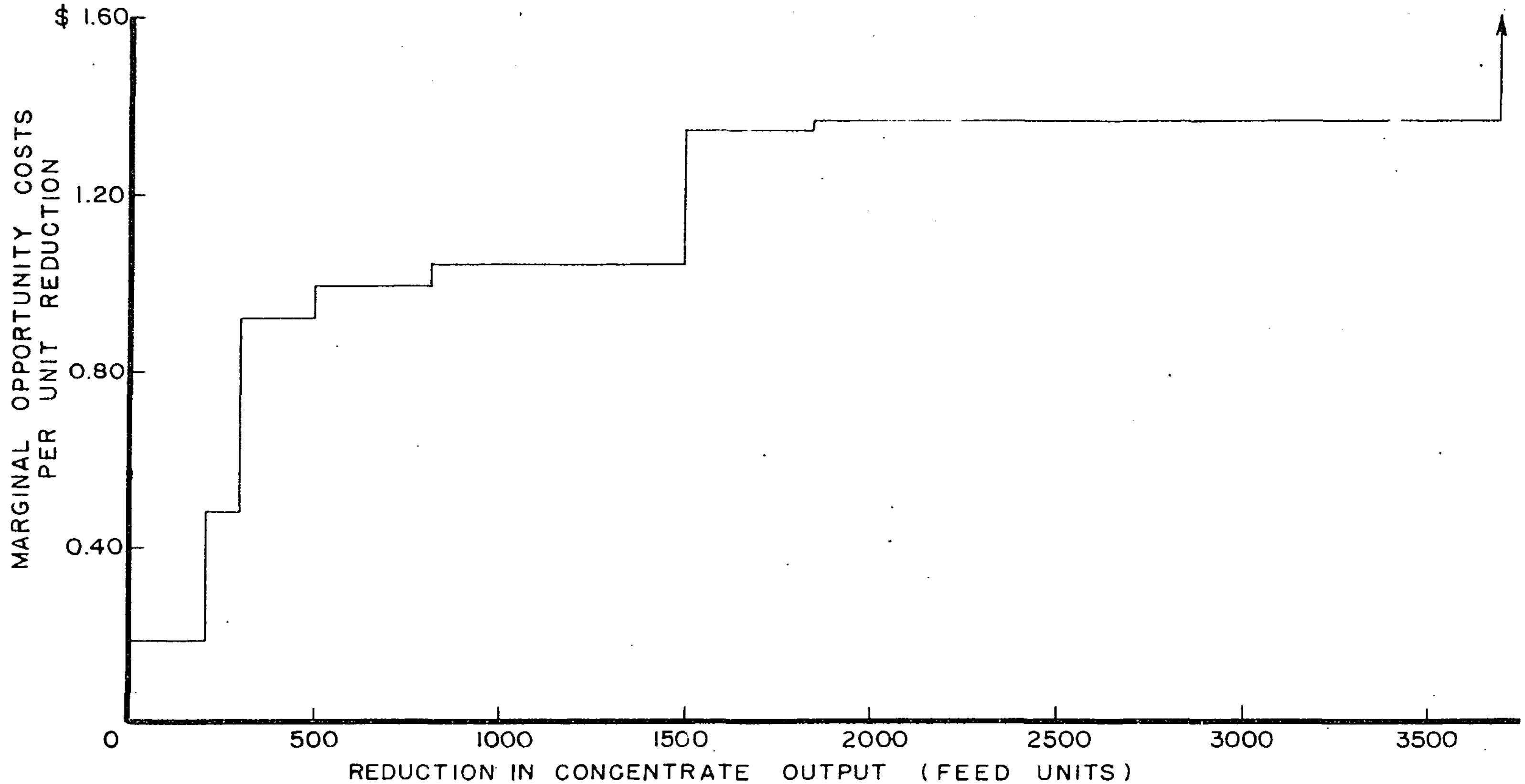

Figure 5. Quota supply function for the bench-mark farm (farm no. 1)

difference is a net profit of $0.34 per bushel to the producer on the 734 bushels given up or $276.

Exchange of quota among producers

The initial allocation of quota to producers will normally be less than the amount that maximizes profit with an uncontrolled output. The portion of each farm's marginal value function lying to the right of the initial allocation forms the demand function of that firm for additional units of quota. The portion of the marginal value function lying to the left of the initial allocation forms the firm's supply function for production quota.

Individual supply and demand functions were aggregated to form aggregate supply and demand schedules for the southern Iowa area. The initial allocation of quota was assumed to be 20 percent less than profit maximizing feed concentrate output. An exchange market for quota was simulated. The market equilibrium was determined at the point where quota sales equaled purchases and the marginal value productivity of quota was the same for all producers.

The equilibrium exchange price was $0.70 per unit of quota--56 percent of the market value of a feed unit. The equilibrium exchange quantity is 1,565,000 bushel units of quota at a value of $1,096,000. Exchange is equal to 6.6 percent of the original quota allocation or 5.3 percent of optimal regional production.

In the quota exchange market as simulated here, only four representative farming situations were, on balance, quota suppliers. The quota supplying farms were farms no. 3, 4, 5 and 6 (a 240-acre, cash grain farm; a 240-acre, intermediate capital farm with a part-time labor supply; a 480-acre, two-man farm with unlimited capital; and a 480-acre, intermediate capital farm). All the quota supplying farms are characterized by a supply of land that is relatively large in comparison to their supply of other resources. The quota supplying farms constitute only 24 percent of the total population of commercial farms. The average amount of quota sold was 691 units or about 17 percent of the farms' original allocation.

The remaining 76 percent of the farms were, on balance, purchasing rather than supplying quota. For most, the quantity purchased was relatively small in comparison to optimum farm output. On the average the quota demanding farms added only 218 units of quota or an average of 9 percent to an original allocation of 2406 units.

The differences between net farm income under an evenly distributed 20 percent reduction in feed concentrate output are shown in Table 24 for representative farming situations. Net farm incomes are shown in the first column for an equally distributed reduction in concentrate output and in the second column for a reduction in output that is

Table 24. Net farm income and value of quota exchanged for typical farm situations and weighted average for the southern Iowa study area under proportionally distributed and under optimally distributed 20 percent reduction in grain output

Farm no.[a]	Net farm income: Proportionally distributed reduction	Net farm income: Optimally distributed reduction	Value of quota exchanged[b]	Net income gain due to quota exchange
1	$ 5,731	$ 6,161	$ -305	$ 125
2	6,827	6,874	- 44	3
3	4,062	3,633	435	6
4	4,662	4,501	237	76
5	13,153	12,780	455	82
6	11,071	10,996	105	30
7	2,995	3,082	- 85	2
8	6,727	7,056	-319	10
9	8,124	8,589	-410	55
10	3,763	3,887	- 98	26
11	7,228	7,754	-459	67
12	4,154	4,212	- 44	14
13	7,459	7,565	- 84	22
Weighted average	4,989	5,019	0	30

[a]Refer to Table 7, p. 40 for a description of farming situations and listing by farm number.

[b]At an average price per bushel unit of $0.70. Negative values indicate purchases.

optimally distributed through a negotiable quota arrangement. As would be expected, quota supplying farms (no. 3, 4, 5 and 6) show lower farm incomes under the optimal distribution. All quota buying farms show increased farm incomes. Receipts from and expenditures for quota sales tend to offset income gains and losses. The value of quota exchanged is shown in the third column of Table 24. Negative values indicate purchases. The value of sales by quota supplying farms more than offset losses in farm income. Negative values of purchases by quota buying farms less than offset gains in farm income. There are positive gains for all farming situations (shown in the last column of Table 25) although some gains are only nominal. The average gain per farm is $30 in southern Iowa.

The income gains due to an exchange of quota are unevenly distributed among farm situations. The greatest gain, either in absolute value or relative to income under an equally distributed reduction in output, is received by farm no. 1, a 240-acre, average, one-man southern Iowa farm with an intermediate supply of capital. The gain of $125 amounts to an average profit of $0.27 on 435 units of quota purchased at the rate of $0.70 per unit. By comparison, farming situation no. 3, a 240-acre, average, one-man cash grain farm, indicates a sale of 621 units of quota for a net income gain of $6 or $0.01 per unit.

Quota selling farms on the average gained much less income from the exchange than did quota buying farms. The aggregate amounts of quota exchanged are, of course, the same; however, the aggregate income gains of the selling farm situations are only 23 percent as large as the gains of quota buying farm situations. The large amount of quota sold at practically no gain by farm no. 3 accounts in a large part for this discrepancy.

SUMMARY AND CONCLUSIONS

Per capita incomes of persons employed in agriculture have been declining relative to the incomes of persons in the remainder of the economy. Efforts to increase farmers' incomes through supported product prices create a need for measures that will control production and prevent the accumulation of surplus stocks. This study has been concerned with the potential effects of a particular type of production control--direct control over the output of feed concentrates.

Individual farms constituted the unit of analysis in this investigation. Representative farms were selected for analysis from two Iowa areas--an eight-county area in the south-central Iowa, Corn Belt fringe area and a seven-county area in the northern Iowa, central Corn Belt cash grain area. A survey of 222 farmers provided basic data for selecting representative farming situations and for constructing a linear programming model to portray the planning environment of the farms.

Linear programming models of representative farming situations were formulated assuming:

1. Average technologies and rates of efficiency in production processes.
2. A short-run planning situation in which land, labor and machinery investments are fixed.
3. Profit maximization as the goal to which production is directed.

The effect of output control was estimated by comparing profit maximizing plans with no control of output to plans with restricted output of feed concentrates.

The imposition of a direct control upon feed concentrate output brought about, in the representative farming situations, compensating increases in the output of alternative products. Substitution of soybeans for corn was a typical response on cash grain farms and other farms that have some sales of crops that are produced in addition to their livestock feeding requirements. Increased beef production was a profitable adjustment to output control for almost all farming situations analyzed. The greatest increases in beef production were in those farming situations that have no limit on use of capital funds. Associated with increased beef output, as a facilitating factor, is increased forage production on land diverted from concentrate producing crops. Increased beef production is generally partially offset by some decrease in pork production.

Substitution of increased output of other products as feed concentrate output is reduced will dampen somewhat the price increasing effects of output control. If all prices are supported there is a danger that surpluses of the substitute products may accumulate. If all prices are not supported, the price gains in the controlled product may be partly offset by decreases, or at the least, less than proportionate increases in the prices of substitute products. The substitute products, soybeans and beef, have the desirable properties of secularly expanding demands and demand functions that are relatively price elastic.

A reduction in the total amount of resources used per farm follows in most farming situations as a result of control over feed concentrate output. Variable costs of crop production and expenditures for commercial fertilizer are decreased as output controls forces a reduction in acreage of intertilled crops and acreage of cropland harvested. Reductions in commercial fertilizer purchases are particularly noticeable with small reductions in concentrate output. A decreased acreage of soil depleting crops and a reduction in the level at which fertility is maintained are both factors contributing to reduced expenditures for fertilizer.

Land, labor and machinery were assumed to be in fixed supply for the short-run model that was used for this analysis. Non-use of resources or decreased marginal value productivities would indicate a tendency toward long-run downward adjustments in the use of resources that are in fixed supply during the short run. The results of analyses of individual farming situations did not reveal any consistent or strong evidence which would portend a transfer of resources to other employments as a long-run outcome of direct control over concentrate output.

Although total resource use per farm is decreased under output control, average resource use per unit of farm production is increased. The decrease in variable costs is not adequate to offset the effect of a decreased output from unchanged fixed costs. Average total cost per dollar of net farm output increases in all farming situations as concentrate output is controlled.

A reduction in feed concentrate output results in an income loss to producers when outputs are valued at the same prices. However, the effects of a price rise resulting from the aggregate output effects of a reduction in concentrate output are adequate to increase net farm income of all farming situations that were analyzed. A mandatory program might be used to secure participation. Producers could logically favor output controls with the knowledge that all other producers would also be required to reduce output and that the gains due to increased prices would accrue to each and all.

A program of output control that is dependent upon voluntary participation must provide some means to compensate producers for the potential income that is lost due to a reduction in output. As small suppliers to a competitive market, producers will evaluate their alternative outputs under a voluntary reduction program at the same prices. The average income loss on representative farms in the southern Iowa area was \$0.50 per feed unit or 40 percent of the market price for feed grain (\$1.25 per bushel of corn) when output of concentrates is reduced by 20 percent. The range in income loss was from \$0.26 per feed unit to \$0.96 per feed unit.

If output control is organized so that producers must reduce output by a fixed amount or not at all, producers will gain by participation at the fixed amount as long as the compensation received is greater than their average income loss per unit reduction in concentrate output. However, with a single payment rate to all producers the level of compensation must be high enough to cover the average income loss of the producer with the highest average income loss per feed unit. In the southern Iowa area, where variation in income loss per feed unit is quite large, compensation at the rate needed to equal loss for all farming situations would result in sizeable over-compensation to those producers with a low income loss per unit reduction in concentrate output.

Exchange of quotas among producers provides some possibility for attainment of higher farm incomes while still maintaining control over output. Producers with high income loss per unit reduction in output can gain by buying quota from those producers with low income losses. Exchange will continue, in a profit maximizing context, until the marginal value productivity of quota is equal for all producers. In the southern Iowa area free exchange of an initial 80 percent quota on concentrate output made possible an income gain of \$30 per farm. The exchange value of quota was \$0.70 per feed unit--56 percent of the market price of feed grain. The gains from exchange of quotas is not large--only \$0.07 per unit of initial allocation. However, the stepped nature of the marginal value productivity schedules derived from the linear programming analyses may cause underestimation of the gain. Also, a downward bias in estimated gain may be caused by the assumptions of average technical efficiency in all production processes and firm profit maximization as the objective of all farming situations. Further research is needed in which these assumptions are relaxed.

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APPENDIX A: SOURCES OF DATA AND PROCEDURES FOR STRATIFYING THE POPULATION OF FARMS

Sources of Data for Stratifying the Population of Farms

Sample survey

A survey of a random sample of farms in each study area provided the primary source of data for estimating the distribution of farms by the four selected characteristics. A cluster sampling procedure was used by the Iowa State College Statistical Laboratory in drawing the sample. The universe from which the sample was drawn included all farms in the study areas that were operating more than 10 acres of cropland or more than 40 acres of cropland and pasture land. The survey was conducted during July, 1959. Completed interviews numbered 132 in southern Iowa and 90 in northern Iowa. The sampling ratio was 1.4/100 in southern Iowa and .9/100 in northern Iowa. The survey questionnaire is given below.

Survey Questionnaire

A. Information on the farm.

1. Are you the operator of a farm? Yes____ No____
2. Is your residence on this farm? Yes____ No____
3. Acres operated

   a. How many acres of land do you own? ________A.
   b. How many acres do you rent from others (cash or share)? __________A.

c. How many acres of farm land do you operate for others as a hired manager? __________A.

d. How many acres do you rent out to others (cash or share)? ___________A.

COMPUTE ACRES OPERATED (a plus b plus c minus d gives acres operated)

Acres operated_______ Acres in seg._____ Acres out of seg._____

4. Do you operate at least 10 acres of tillable cropland or at least 40 acres cropland and pasture land?
Yes_______ No________

IF YES FOR QUESTION 1, 2, and 4, COMPLETE A SCHEDULE FOR ALL LAND THIS INDIVIDUAL OPERATES

5. Do you operate any of this land in partnership with another person? Yes________ No________

IF YES: With whom and what is the arrangement?

____

____

B. Information on farm resources and expenditures

1. Labor

a. How much hired help did you have from June 1, 1958 to June 1, 1959?

Number of full-time hired men ____________
Weeks of part-time hired help ____________
Total spent for hired labor $____________

b. What custom work if any did you have done from June 1, 1958 to June 1, 1959?

Jobs done by custom work

____

____

____

What was the total amount which you spent for custom work during this time? $_____________

c. Did you work off your farm for wages between June 1, 1958 and June 1, 1959? Yes____ No____

IF YES: What type of work?________________
How many weeks? ________________
How many hours per week?____________

d. Average number of hours per week that each member of the family or regular hired worker was available and willing to work on this farm, if needed, during the past year.

Workers	Age	Dec-Feb	Mar-Apr	May-June	July-Aug	Sept-Nov	Work off this farm past year
Operator							
Wife							
Sons							
Daughters							
Others in household							
Regular hired							

2. What would you estimate to be the present sale value of your machinery $______________

3. How much did you spend for commercial fertilizer and lime during 1958? $____________________

C. Livestock program for the period June 1, 1958 to June 1, 1959.

1. Hogs

a. 1958 fall pig crop

How many sows farrowed between June 1, 1958 and Dec. 1, 1958? __________

How many feeder pigs did you buy last fall?______
How many fat hogs did you sell this spring?______

b. 1958-59 spring pig crop

How many sows farrowed between Dec. 1, 1958 and June 1, 1959? __________
How many feeder pigs did you buy this spring?____
How many fat hogs do you plan to sell this fall?______

c. Is this about your usual hog operation?
Yes ______ No ______

IF NO: Note any significant difference and reason for difference.

2. Stock cattle

a. How many beef cows were in your breeding herd Jan. 1 this year? ________
b. How many calves or feeder calves (not grain fed) were sold between June 1, 1958 and June 1, 1959?

No.______________ Month__________ Weight________

______________ __________ ________

c. How many of these calves had you purchased from off your farm?

No.______________ Month__________ Weight_________

d. Is this about your usual stock cattle operation?
Yes________ No________

IF NO: Note any significant difference and reason for difference.

3. Fat cattle

a. How many fat cattle did you market during the period June 1, 1958 to June 1, 1959?
No.______________ Month__________ Weight__________

b. How many days were they on full feed of grain?____
c. How many of these had you purchased from off of your farm?

No.______________ Month__________ Weight__________

d. Is this about your usual beef feeding operation?
Yes______ No______

IF NO: Note any significant difference and reason for difference.

4. Dairy cattle

a. How many milk cows were on hand Jan. 1 this year?__________
What was the average production per cow last year?__________ lbs. of butterfat.

b. How is your milk marketed?
Grade 'A' fluid milk ______
Grade 'B' fluid milk ______
Cream _______

c. Is this about your normal dairy operation?
Yes______ No______

IF NO: Note any significant difference and reason for difference.

5. Sheep

a. How many ewes did you have on January 1 of this year?________
b. How many feeder lambs did you buy during the period June 1, 1958 to June 1, 1959?________
c. How many fat lambs did you sell during the period June 1, 1958 to June 1, 1959?________
d. Is this about your normal sheep operation?
Yes______ No______

IF NO: Note any significant difference and reason for difference.

6. Poultry

a. How many pullets did you put in your laying flock last fall?________
b. How many fryers or broilers were sold since June 1 of last year?________
c. How many turkeys did you raise last year?______

D. Cropping program and land resources

Crop	Acres harvested	Yield/ acre	Production 1958	Fertilizer lbs./acre	Acres planted 1959
Corn					
Oats					
Soybeans					
Other					
Hay					
Rotated meadow					
Acreage reserve					
Cons. reserve					
Permanent pasture					
Idle farmstead					

Conservation needs inventory

The Conservation Needs Inventory (71) was used in this study to estimate the soil resources of the study areas.

The Inventory has been conducted over a period of years as a cooperative effort of various federal, state and local agencies. The Soil Conservation Service has had responsibility for co-ordinating the work.

The Conservation Needs Inventory was based on a 2-percent sample of tracts of land. In Iowa, the sample tracts were 160 acres (1/4 section) in size. Aerial photographs of each sample tract were mapped and the land in the tract classified by soil type, slope, erosion damage, present use and use capability class.* Sample tracts were aggregated to estimate county totals.

U.S. Census of Agriculture

The 1959 United States Census of Agriculture (61) was used to supplement sample survey data in stratifying the population of farms. The Census data has the desirable property of providing an estimator with small variance. Census data that are tabulated from an enumeration of all farms have no sampling error. Some data appearing in the

*Class I - Suitable for very intensive cultivation.
Class II - Suitable for intensive cultivation.
Class III - Suitable for moderate cultivation.
Class IV - Suitable for limited cultivation.
Classes V to VIII - Not suited for cultivation.

Census are obtained from a 20 percent sample of farms. Although these data are subject to some sampling error, the errors are small due to the large size of the sample. Where comparable measurements of the same characteristic are available both from the Census (either complete enumeration or 20 percent sample) and from the sample survey (1.4 or 0.9 percent sample) the Census estimator will be more desirable because of its low variance.* It would have been desirable to use the Census data throughout for estimating the joint distribution of farms; however, Census material has two major limitations. First, the measurements of farm characteristics may not be the most desirable for purposes other than those for which they were collected. Second, there are very few cross tabulations that can be used in establishing the joint distribution of farms according to two or more characteristics. As a result, the Census is primarily useful for establishing marginal distributions of farms. Estimates of joint distributions must be drawn from other sources.

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*Assume that both the 20 percent Census sample and the 1.4 percent survey sample measure the same characteristic in the same population of farms. The expected value of the variance of a sample mean is σ^2/n where σ^2 is the population variance and n is the number of observations in the sample. In the Census 20-percent sample n = 20/1.4 = 14.3 times the n of the sample survey. Therefore, the expected value of the variance of a sample mean is only 1/14.3 times as large for estimates based on data from the Census sample as for estimates based on sample survey data.

Procedures Used to Stratify the Population of Farms

Estimation of the marginal distributions of farms by each of four characteristics was the first step in the process of stratifying the population of farms. Marginal distributions give the numbers (or relative frequencies) of farms classified on the basis of a single characteristic. Differences among farms in respect to other characteristics are ignored in forming marginal distributions. The joint distribution of farms was estimated after the marginal distributions had been established. A joint distribution gives the numbers (or relative frequencies) of farms classified on the basis of two or more characteristics. The joint distribution which it was the objective of this procedure to establish gives relative frequencies of farms classified on the basis of four characteristics--size, topography, labor supply and capital supply.

Marginal distribution of farms by size

The distribution of farms by size was obtained from the 1959 Census of Agriculture (61). Definitions of strata used to approximate the distribution were:

Southern Iowa

- 30 - 179 acres
- 180 - 299 acres
- 300 or more acres

Northern Iowa

- 30 - 239 acres
- 240 or more acres.

Tabulation of the marginal distributions (strata totals) from Census data involved only straight forward grouping of more finely-divided size classes, with one exception. The Census tabulations group farms with 260 to 499 acres in one large class. In order to estimate the number of farms for the southern Iowa strata that includes farms of 180 to 299 acres, it was necessary to divide the 260- to 499-acre Census class into two subclasses. The division into subclasses was made by a linear interpolation between the average frequencies (average number of farms per one-acre interval) at class midpoints.

Marginal distribution by topography

Although other variables are involved in a complete topographic description of an area or tract of land, only slope was used in this study. The Conservation Needs Inventory summary was used to estimate the distribution of land by slope within each study area. In the northern Iowa area farms were not stratified by soil resources. Individual farms were assumed to be not greatly different from the area average. Land was divided only into that which was well suited to continuous cropping (0-3 percent slope) and that for which rotation of crops is desirable under present practices (more than 3 percent slope).

Farms in the southern Iowa area were divided into three strata on the basis of productivity. Tracts of land that were part of the Conservation Needs Inventory were stratified on the basis of a corn yield index. The corn yield index was equivalent to expected corn production per acre of all land and thus reflects both the frequency of corn crops in crop rotations and the yield of corn per acre harvested. Topography, as indicated by slope, is a major determinant of the corn yield index. The average distribution of soils by slope was used to specify soil resources on tracts of land within each productivity group.

Marginal distribution by labor supply

The marginal distribution of farms by hours of labor available was computed from sample survey data. Hours of off-farm work by the operator, labor hired, and man-equivalent work units of family labor (one hour of family labor was assumed to be equal to three fourths of an hour of operator or hired labor) were computed for each of the sample farms. Farms were classified as part-time, one-man, or two-man farms.

A part-time farm was defined as any in which off-farm work by the operator exceeded hired and family labor. A one-man farm was defined as one in which hired and family labor was equal to operator off-farm work or exceeded it by no more than 1000 hours per year. Farms having more than a 1000 hour excess of hired and family labor over off-farm work were defined as two-man farms. The total number of hours available for each labor class was calculated by assuming that operators worked 2400 hours per year.

<u>Marginal distribution by capital supply</u>

The available supply of operating capital is an important determinant of profit maximizing farm organization. Operating capital is defined in this study to include funds used for current operating expenses and funds invested in livestock. Precise information as to the amount of capital available on farms was not available. Livestock production in relation to feed produced on the farm was used as a substitute variable to indicate capital supply. Variations in the amount of operating capital used are primarily associated with variations in type and scale of livestock enterprises since funds required for the purchased inputs of crop production do not vary greatly among farms of the same size.

Southern Iowa sample farms were classified on the basis of the ratio of feed fed to feed produced as:

Cash grain	feed fed/feed produced	0 to 0.5
Intermediate capital	feed fed/feed produced	0.5 to 1.0
Unlimited capital	feed fed/feed produced	greater than 1.0.

Feed fed was estimated on the basis of reported livestock production and Jennings' estimate of feed used per head and per unit of product of livestock (30, pp. 42-43). Crop production was taken as reported for the 1958 crop year and converted to feed units on the basis of relative feeding value of crops (see p. 12 above).

Joint distribution of farms

The joint distribution of farms in the southern Iowa area by size, topography, labor supply and capital supply was approximated by a three-strata subdivision within each characteristic. The sample survey data was the primary source of information for estimating the joint distribution of farms. However the number of farms in the sample survey was too small to permit straightforward estimation of frequencies in all cells of the joint distribution table.

For some combinations of characteristics, it was possible to obtain a cross tabulation of sample or census data. The joint distribution of sample survey farms by size and by crop production per acre was tabulated. The null hypothesis of no association between the two characteristics was not rejected at the 95 percent level of confidence on the basis of a chi-square contingency test. The distribution of farms by labor supply and by capital supply was tabulated within each of three farm size classes.

Remaining interior cells in the table of relative frequencies were assigned on the basis of assumed independence between characteristics or on the basis of judgment estimates. All adjustments on the basis of judgment were made subject to the condition that empirically estimated marginal and joint distributions remain unchanged by the final assignment of frequencies. The final assignment of relative frequencies is shown in Table 25. Weights for aggregation, derived from the relative frequencies, are presented in Table 26.

Table 25. Estimated relative frequency distribution of farms by four characteristics, southern Iowa[a]

Labor and capital supply	Relative frequencies by farm size and by land quality								
	30-179 acres			180-299 acres			300 or more acres		
	Rough	Average	Level	Rough	Average	Level	Rough	Average	Level
Part-time									
Cash grain	0	.011	.006	0	.003	.001	0	0	0
Intermediate	.027	.018	.001	.005	.006	0	0	0	0
Unlimited	.003	.017	0	.002	.001	0	0	0	0
One-man									
Cash grain	0	.047	.027	0	.038	.013	0	.039	.011
Intermediate	.116	.076	.005	.057	.067	.005	.030	.026	0
Unlimited	.014	.072	0	.023	.015	.001	.016	.003	0
Two-man									
Cash grain	0	0	0	0	.013	.004	0	.027	.011
Intermediate	0	0	0	.019	.022	.002	.024	.026	0
Unlimited	0	0	0	.008	.005	0	.022	.015	0

[a]Relative frequencies give the proportion of the total population of farms that fall within the bounds of the indicated subclass.

Table 26. Weights used in aggregation (relative frequency of representative farming situations and of approximated farming situations and weights for aggregation

Farm no.	Frequency of: Representative situations	Frequency of: Approximated situations	Weights for: Farm no. aggregates	Weights for: Size-related aggregates[a]
1	.067	.104	.171	.1257
2	.015	.128	.143	.1048
3	.038	.141	.179	.2157
4	.006	0	.006	.0060
5	.026	0	.026	.0260
6	.026	0	.026	.0260
7	.018	0	.018	.0180
8	.013	.059	.072	.0767
9	.005	.002	.007	.0070
10	.057	.186	.243	.1889
11	.030	.005	.035	.0324
12	.023	.033	.056	.0772
13	.016	.002	.018	.0170
Total	.034	.660	1.000	.9214

[a]When approximated situations are derived by scale adjustment of the representative situation, weights for size-related aggregates are adjusted accordingly. On balance, scaling down was encountered more often than scaling up. As a result, the sum of weights for size-related aggregates is less than 1.00.

APPENDIX B: BASIC DATA FOR LINEAR PROGRAMMING ANALYSES

Table 27. Resource supplies by strata within each of four characteristics (southern Iowa)

Item	Unit	First stratum	Second stratum	Third stratum
Farm size				
Stratum name		Small	Medium	Large
Land in farm	acres	110	240	480
Topography				
Stratum name		Rough	Average	Level
Percentage distribution of land				
Class I	percent	1.9	6.0	34.5
Class II	percent	9.8	25.6	29.1
Class III	percent	23.9	36.9	21.5
Permanent pasture[a]	percent	31.1	20.3	11.5
Woodland pasture[a]	percent	20.4	5.7	0.7
Idle and waste	percent	12.9	5.5	2.7
Labor supply				
Stratum name		Part-time	One-man	Two-man
Annual labor supply	man hours	1000[b]	2700	4500
Seasonal labor supply				
Dec.-Jan.-Feb.	man hours	300	545	995
Mar.-Apr.	man hours	200	416	716
May-June	man hours	200	570	870
July-Aug.	man hours	200	441	741
Sept.-Oct.-Nov.	man hours	300	728	1178
Capital supply				
Stratum name		Cash-grain[c]	Inter-mediate	Unlimited
110-acre farm	$	2300-2975	4500	d
240-acre farm	$	2600-3550	6300	d
480-acre farm	$	3200-4700	12600	d

Table 28. Resource supplies by strata within each of three characteristics (northern Iowa)

Item	Unit	First stratum	Second stratum
Farm size			
Stratum name		Small	Large
Land in farm	acres	160	330
Cropland	percent	86.3	86.3
Permanent pasture[a]	percent	6.2	6.2
Timber, idle, waste	percent	7.5	7.5
Labor supply			
Stratum name		One-man	Two-man
Annual labor supply	man hours	2700	4500
Seasonal labor supply			
Dec.-Jan.-Feb.	man hours	545	995
Mar.-Apr.	man hours	416	716
May-June	man hours	570	870
July-Aug.	man hours	441	741
Sept.-Oct.-Nov.	man hours	728	1178
Capital supply		Cash-grain[b]	Unlimited
160-acre farm	$	4000	c
330-acre farm	$	5400	c

[a]Permanent and woodland pasture were represented in the programming restraints as initial quantities of forage. Permanent pasture was assumed to yield the equivalent of 0.75 tons of hay per year. Woodland pasture was assumed to yield one-half as much per acre as permanent pasture.

[b]Capital supply for cash grain situations varied according to topography to reflect differences in crop costs due to differences in acres of cropland farmed. Costs are shown for average and level topography.

[c]Capital was not limited in absolute amount but was limited in use to the maximum amount that would return at least 6 percent interest on investment.

Table 29. Crop yields and fertilizer costs by fertility level for selected rotations in the Shelby-Grundy-Haig soil areas (52)

Slope and rotation		Crop yields by fertility level		Fertilizer costs
		Low fertility	Intermediate fertility	Intermediate fertility
0-1 percent slope				
Corn	bu.	42	48	$4.46
Corn	bu.	40	46	3.78
Soybeans	bu.	18	20	.30
Corn	bu.	43	48	4.46
Soybeans	bu.	20	20	.30
Soybeans	bu.	18	17	.96
Corn	bu.	43	50	4.46
Oats	bu.	27	33	1.06
Meadow	tons	1.8	2.1	.12
Corn	bu.	47	53	2.12
Corn	bu.	43	50	3.72
Oats	bu.	27	33	1.06
Meadow	tons	1.8	2.1	.12
Meadow	tons	1.2	1.4	.80
2-5 percent slope				
Corn	bu.	43	50	3.90
Corn	bu.	39	46	3.34
Soybeans	bu.	18	21	.18
Corn	bu.	50	55	1.50
Soybeans	bu.	20	22	
Corn	bu.	46	50	4.00
Oats	bu.	32	36	2.36
Meadow	tons	2.0	2.2	
Corn	bu.	47	53	1.50
Soybeans	bu.	20	22	.18
Soybeans	bu.	19	21	.72
Oats	bu.	27	33	2.36
Meadow	tons	1.8	2.1	
Corn	bu.	50	55	1.74
Corn	bu.	48	53	3.52
Oats	bu.	32	35	1.50
Meadow	tons	2.0	2.2	0

Table 29 (Continued)

Slope and rotation		Crop yields by fertility level: Low fertility	Crop yields by fertility level: Intermediate fertility	Fertilizer costs: Intermediate fertility
Corn	bu.	51	56	$1.74
Corn	bu.	47	53	3.52
Oats	bu.	32	36	1.50
Meadow	tons	2.0	2.2	0
Meadow	tons	2.1	2.3	.18
6-12 percent slope				
Corn	bu.	30	35	4.15
Corn	bu.	27	33	5.24
Oats	bu.	20	24	1.32
Meadow	tons	1.1	1.3	.24
Meadow	tons	1.2	1.4	.60
Corn	bu.	30	35	4.16
Corn	bu.	27	33	5.24
Oats	bu.	20	24	1.32
Meadow	tons	1.2	1.3	.24
Meadow	tons	1.2	1.4	.60
Meadow	tons	1.2	1.4	.60
Corn	bu.	30	35	4.02
Oats	bu.	21	25	.54
Meadow	tons	1.1	1.3	.42
Meadow	tons	1.2	1.4	.48
Corn	bu.	32	36	3.90
Oats	bu.	18	23	.54
Meadow	tons	1.1	1.3	.42
Meadow	tons	1.2	1.4	.48
Meadow	tons	1.2	1.4	.60

Table 30. Crop yields and fertilizer costs by fertility level for selected rotations in the Clarion-Webster soil areas (52)

Rotation	Crop yields by fertility level			Fertilizer costs by fertility level	
	Low	Intermediate	Optimum	Intermediate	Optimum
Corn		60	66	6.80	17.00
Corn		61	67	5.48	13.70
Corn		58	64	4.34	10.85
Soybeans		21	24	0	0
Corn		61	67	4.96	12.40
Soybeans		21	24	0	0
Soybeans		20	23	1.08	2.70
Corn	54	63	69	2.60	6.50
Soybeans	21	25	28	0	0
Corn	52	61	67	5.12	12.50
Oats	37	45	51	.52	1.30
Meadow	2.5	2.8	3.0	.96	2.40
Corn	54	63	69	2.60	6.50
Corn	52	61	67	3.80	9.50
Oats	35	44	51	0	0
Meadow	2.5	2.8	3.0	1.20	3.00
Corn	56	65	71	2.60	6.50
Corn	53	62	68	3.66	9.15
Oats	37	45	51	0	0
Meadow	2.3	2.8	3.0	1.20	3.00
Meadow	2.6	2.9	3.1	1.08	2.70
Oats (silage or hay)	1.4	1.7	1.9	0	0
Meadow	2.3	2.8	3.0	1.98	4.95
Meadow	2.6	2.9	3.1	1.98	4.95
Meadow	2.3	2.8	3.0	1.98	4.95
Meadow	1.8	2.5	2.7	1.98	4.95

Table 31. Crop production requirements (operating expenses and labor requirements per acre by crops and by type of equipment)

Type of equipment and crop	Machinery operating costs	Seed and spray	Labor by seasons				
			Dec.-Jan.-Feb.	Mar.-Apr.	May-June	July-Aug.	Sept.-Oct.-Nov.
3-plow, 2-row	($)	($)	(hrs.)	(hrs.)	(hrs.)	(hrs.)	(hrs.)
Corn	4.71	3.14[a]	.302	.684	2.036	.621	2.158
Oats	2.97	1.51	0	.825	0	2.475	0
Soybeans	4.40	3.65	0	.580	2.262	.638	2.320
Meadow[b]	10.00	4.75[a]	0	0	2.334	1.987	1.680
3-plow, 2-row with custom harvesting							
Corn	7.85	3.14[a]	.302	.684	2.036	.431	1.418
Oats	5.75	1.51	0	.825	0	1.915	0
Soybeans	7.22	3.65	0	.580	2.262	.638	1.410
Meadow[b]	10.00	4.75[c]	0	0	2.334	1.987	1.680
4-plow, 4-row							
Corn	4.61	3.14[a]	.285	.464	1.601	.450	2.00
Oats	3.21	1.51	0	.795	0	2.335	0
Soybeans	4.92	3.65	0	.440	1.820	.330	2.210
Meadow[b]	10.00	4.75[c]	0	0	2.334	1.987	1.680

[a]Includes $1.00 per acre for spraying corn. Seed costs on Class III land (Shelby 6-12% slope) are lower by $.46 per acre to reflect a reduced seeding rate in line with lower fertility.

[b]Machinery costs and labor requirements for hay are based on an assumed 2 cuttings of 1 ton each. In programming matrix costs of hay production costs were charged on tonnage basis.

[c]For a one-year meadow, lower quality seed is used resulting in seed costs that are lower by $2.80 per acre.

Table 32. Resource requirements, costs, and returns for hog enterprises at 1961 prices

Type of enterprise	Spring and fall farrowing in proportion of 2:1[a]			Late spring to early summer farrowing		
	Amount	Price	Value	Amount	Price	Value
Investment						
Gilts	450 lb.	$14.50	$65.25	225 lb.	$14.50	$32.63
Equipment			33.19			14.17
Total			98.44			46.80
Annual cost						
Operating expenses			72.74			22.50
Protein supplement	2033 lb.	3.90	79.29	655 lb.	3.90	25.55
Total			152.03			48.05
Sales						
Barrows & Gilts (spring)	2440 lb.	14.18	345.85	1224 lb.	13.14	160.83
" " (fall)	1443 lb.	14.50	209.53			
Sow (spring)	300 lb.	12.22	36.66	300 lb.	12.80	38.41
" (fall)	400 lb.	12.05	48.02			
Total			640.24			199.24
Net revenue			488.21			151.19
Capital[b]			221.81			94.85
Labor	85 hrs.			26 hrs.		
Feed fed						
Corn	335 bu.			109 bu.		
Legume pasture	2 tons			1 ton		

[a]The same enterprise when exceeding 15 litters in southern Iowa or 25 litters in northern Iowa was assumed to require $30 additional capital for investment in buildings. In addition output was reduced by 5 percent to reflect decreasing returns to scale. Resulting gross and net revenues were lowered by $45.88.

[b]Investment plus annual cost minus allowance for costs financed out of mid-year sales.

Table 33. Resource requirements, costs and returns for beef feeding enterprises at 1961 prices

Type of enterprise	Yearlings - Dry lot Nov. to May			Yearlings - Pasture fed Nov. to Nov.			Calves - Deferred fed on pasture - Oct. to Dec. year following		
	Amount	Price	Value	Amount	Price	Value	Amount	Price	Value
Investment									
Equipment			$6.77			$6.77			$6.77
Annual cost									
Operating expenses			11.42			15.07			14.26
Protein supplement	360 lb.	$4.10	14.76	40 lb.	$4.10	1.64	125 lb.	$4.10	5.12
Feeder stock	690 lb.	21.16	146.00	610 lb.	21.16	129.08	450 lb.	22.78	102.54
Total			172.18			145.79			121.92
Sales									
Fat steer	1150 lb.	22.30	256.45	1120 lb.	23.32	261.07	1000 lb.	22.34	223.40
Net revenue			84.27			115.28			101.48
Capital			178.95			152.56			128.69
Labor	13.5 hrs.			23.73 hrs.			25.9 hrs.		
Feed fed									
Corn	54 bu.			47.5 bu.			53 bu.		
Hay	.3 ton			1.24 ton			.8 ton		
Pasture (hay eq.)				1.80 ton			1.44 ton		

Table 34. Resource requirements, costs and returns for beef cow herds at 1961 prices

Type of enterprise	Beef cow - Calf sold			Beef cow - Calf fed		
	Amount	Price	Value	Amount	Price	Value
Investment						
Equipment			$17.50			$17.50
Cows	1100 lb.	$16.00	176.00	1100 lb.	$16.00	176.00
Replacement	13.3 %		23.41	13.3 %		23.41
Total			216.91			216.91
Annual cost						
Operating expenses			16.95			38.92
Protein supplement				103 lb.	4.10	4.22
Total			16.95			43.14
Sales						
Cull cow	137.5 lb.	14.00	19.25	137.5 lb.	14.00	19.25
Calf Gd-ch	349 lb.	32.12	77.20			
Choice steer				443 lb.	22.34	98.97
Choice heifer				320 lb.	21.34	68.29
Total			96.45			186.51
Net revenue			79.50			143.37
Capital			233.86			266.31
Labor	18.5 hrs.			37.2 hrs.		
Feed fed						
Corn	6.7 bu.			46.5 bu.		
Hay	1.15 ton			1.76 ton		
Pasture (hay eq.)	4.32 ton			5.42 ton		

Table 35. Resource requirements, costs and returns for dairy cow herds at 1961 prices

Type of enterprise	Small dairy herd - hand milked		
	Amount	Price	Value
Investment			
Equipment			$39.50
Cows		$180.00	180.00
Replacement	.377 %		67.80
Total			287.30
Annual cost			
Operating expenses			50.43
Protein supplement	175 lb.	4.10	7.18
Total			57.61
Sales			
Cull cow (.20)	1250 lb.	12.00	30.00
2 yr. heifer (.122)		144.00	17.57
Vealer (.410)	110 lb.	15.00	8.12
Butterfat	236 lb.	.595	140.42
			196.11
Net revenue			133.60
Capital			292.10
Labor	145.5 hrs.		
Feed fed			
Corn	31.4 bu.		
Hay	3.74 ton		
Pasture (hay eq.)	2.61 ton		

Fixed Costs

Taxes and interest on investment

The average value of land and improvements was taken from the preliminary 1959 Census of Agriculture for Iowa (61). In the southern Iowa area land had an average value of $117 per acre. In the northern Iowa area the average value of land was $298 per acre. Value differentials for land of high or low quality in the southern area were taken from a 1960 survey of farm real estate dealers (17, p. 639). Level land was estimated at 70 percent above average value. Rough land was estimated at 48 percent below average value. Interest charges were assumed to be 6 percent of the value of land (69, p. 6).

Real estate taxes were adjusted for area taxing rate differentials from the state average levy $1.13 per $100 of full value (68). The average tax levy (29, p. 86) in the southern Iowa counties was 117 percent of the state levy or $1.32 per $100 of full value. The average levy in the northern Iowa counties was 93 percent of the state average levy or $1.05.

Tax assessments tend to vary less than in proportion to market value (37, p. 8). An average index of regressivity for Iowa of 1.12 was used to adjust for differences in tax assessments rates on rough and level land in southern Iowa. The index of regressivity is equal to the average tax assessment ratio divided by the ratio of assessed value to market value on transferred property. The estimated tax assessment on rough land in southern Iowa was computed by multiplying the area average assessment by the index of regressivity. The assessment on level land was computed by multiplying the area average assessment by the reciprocal of the regressivity index.

In estimating machinery investment for typical farms, an attempt was made to reflect the correlation of quality as well as quantity of machines with farm size. Linear regressions were computed for machinery investment as a function of crop acres on 132 farms in the southern Iowa area and 91 farms in the northern Iowa area. The derived estimating equations were:

(South) Investment = 840 + 27.13 (A. cropland)

(North) Investment = 2200 + 15.84 (A. cropland).

Interest on machinery investment was calculated at 6 percent of the investment. Taxes were estimated on the basis of the same levy per $100 of full value as was used on land.

<u>Depreciation, repairs and insurance</u>

Depreciation, repairs and insurance on improvements and machinery were taken from a summary of records for Iowa farms (54, p. 5). Estimated cost by farm size:

	Southern Iowa	Northern Iowa
Small farms	$ 840	$ -
Medium farms	1,559	1,828
Large farms	2,585	2,711 .

The reported farm sizes are near those used in this study for the southern Iowa area. In the northern Iowa area, an interpolation was made between size groups as reported in the records summary to bring closer correspondence with sizes assumed for the analysis.

APPENDIX C: PROFIT MAXIMIZING FARM PLANS FOR INDIVIDUAL FARMING SITUATIONS

Table 36. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 1 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	62.4	57.5	50.0	22.9
Soybeans	acres	16.8	17.2	7.1	24.4
Oats	acres	26.5	25.0	23.9	22.5
Meadow	acres	55.3	51.8	44.2	44.9
Crop production					
Feed grain	bu.	3080	2623	2660	1349
Soybeans	bu.	370	425	165	518
Hay and meadow	tons	86	74	69	79
Permanent pasture	tons	41	41	41	41
Livestock					
Hogs	litters	21	15	15	3
Fat cattle	head	12	17	17	25
Beef cows	head	0	0	0	0
Dairy cows	head	5	5	5	5
Feed fed					
Feed grain	bu.	3080	2623	2660	1349
Protein suppl.	cwt.	156	118	118	84
Forages	tons	83	94	98	107
Costs and returns					
Net farm output	$	7904	7459	7049	5766
Variable costs	$	1663	1359	1318	869
Net farm income	$	6241	6100	5731	4897
Fixed costs	$	4727	4727	4727	4727
Labor returns	$	1514	1373	1004	170
Imputed marginal productivities					
Class I cropland	$/acre	40.48	8.12	2.68	0.65
Class II cropland	$/acre	30.80	6.18	3.29	2.11
Class III cropland	$/acre	8.86	0	0	0
Permanent pasture	$/acre	0	0	0	0
All land	$/acre	13.61	2.07	1.01	0.58
Hay	$/ton	0	0	2.20	2.78
Labor (seasonal)	$/hr.	0	0	0	0
Labor (annual)	$/hr.	0	0	0	0
Capital	$/$ invested	0.44	0.39	0.35	0.34
Quota	$/feed unit	0	0.92	1.09	1.14

Table 37. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 2 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	62.4	50.2	44.8	33.1
Soybeans	acres	4.7	4.7	0	0
Oats	acres	26.5	28.0	30.0	25.2
Meadow	acres	67.4	78.1	86.2	102.7
Crop production					
Feed grain	bu.	3127	2800	2627	1969
Soybeans	bu.	103	103	0	0
Hay and meadow	tons	113	126	138	156
Permanent pasture	tons	41	41	41	41
Livestock					
Hogs	litters	34	30	23	19
Fat cattle	head	44	51	56	59
Beef cows	head	0	0	0	7
Dairy cows	head	0	0	0	4
Feed fed					
Feed grain	bu.	5578	5787	5093	4934
Protein suppl.	cwt.	251	230	175	152
Forages	tons	152	167	179	197
Costs and returns					
Net farm output	$	9584	9410	8959	8327
Variable costs	$	1934	1873	1622	1767
Net farm income	$	7650	7537	7337	6560
Fixed costs	$	5226	5226	5226	5226
Labor returns	$	2424	2311	2111	1334
Imputed marginal productivities					
Class I cropland	$/acre	48.78	25.80	20.72	18.52
Class II cropland	$/acre	48.07	28.75	25.24	18.52
Class III cropland	$/acre	27.04	16.63	15.91	14.72
Permanent pasture	$/acre	6.83	13.04	11.21	6.92
All land	$/acre	26.84	18.10	16.20	12.91
Hay	$/ton	21.27	15.64	17.15	20.64
Labor (seasonal)	$/hr.	0.48	1.18	1.03	0.71
Labor (annual)	$/hr.	0.11	0.19	0.17	0.12
Capital	$/$ invested	0.06	0.06	0.06	0.06
Quota	$/feed unit	0	0.58	0.77	1.15

Table 38. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 3 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	62.4	62.9	39.8	17.0
Soybeans	acres	16.8	15.8	33.5	33.5
Oats	acres	26.5	26.7	23.6	12.2
Meadow	acres	55.3	55.6	86.6	12.4
Crop production					
Feed grain	bu.	3080	2781	1812	1071
Soybeans	bu.	370	326	690	690
Hay and meadow	tons	86	76	66	26
Permanent pasture	tons	41	41	41	41
Livestock					
Hogs	litters	5	5	5	5
Fat cattle	head	8	11	10	8
Beef cows	head	0	0	0	0
Dairy cows	head	0	0	0	0
Feed fed					
Feed grain	bu.	990	1111	1090	969
Protein suppl.	cwt.	41	47	47	40
Forages	tons	24	43	33	37
Costs and returns					
Net farm output	$	5510	4961	4764	4150
Variable costs	$	1168	715	702	592
Net farm income	$	4342	4246	4062	3558
Fixed costs	$	4505	4505	4505	4505
Labor returns	$	-188	-284	-468	-972
Imputed marginal productivities					
Class I cropland	$/acre	36.42	14.42	9.88	9.81
Class II cropland	$/acre	27.98	12.33	8.65	8.30
Class III cropland	$/acre	7.40	0.99	0	0
Permanent pasture	$/acre	0	0	0	0
All land	$/acre	13.61	4.40	2.82	2.72
Hay	$/ton	0	0	0	0
Labor (seasonal)	$/hr.	1.54	4.46	1.54	0.50
Labor (annual)	$/hr.	0.31	0.89	0.31	0.10
Capital	$/$ invested	0.40	0.36	0.40	0.43
Quota	$/feed unit	0	0.39	0.64	0.70

Table 39. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 4 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	58.2	51.1	44.1	31.3
Soybeans	acres	4.7	4.7	4.7	1.0
Oats	acres	32.0	26.6	19.6	15.6
Meadow	acres	66.1	49.7	34.9	33.8
Crop production					
Feed grain	bu.	3241	2917	2561	1989
Soybeans	bu.	103	103	103	22
Hay and meadow	tons	104	81	58	62
Permanent pasture	tons	41	41	41	41
Livestock					
Hogs	litters	10	10	10	6
Fat cattle	head	1	4	9	21
Beef cows	head	15	14	12	6
Dairy cows	head	0	0	0	0
Feed fed					
Feed grain	bu.	1290	1449	1569	1736
Protein suppl.	cwt.	71	72	69	52
Forages	tons	91	97	97	103
Cost and returns					
Net farm output	$	6345	6128	5872	5212
Variable costs	$	1510	1371	1210	949
Net farm income	$	4835	4757	4662	4263
Fixed costs	$	4283	4283	4283	4283
Labor returns	$	552	474	379	-20
Imputed marginal productivities					
Class I cropland	$/acre	21.45	14.62	9.45	0.34
Class II cropland	$/acre	18.65	12.31	9.27	1.05
Class III cropland	$/acre	1.97	0	0	0
Permanent pasture	$/acre	0	0	1.19	0.96
All land	$/acre	6.89	4.04	3.22	0.51
Hay	$/ton	0	0	1.42	1.53
Labor (seasonal)	$/hr.	6.15	3.42	3.44	3.49
Labor (annual)	$/hr.	2.09	1.78	1.83	0.83
Capital	$/$ invested	0.18	0.20	0.16	0.18
Quota	$/feed unit	0	0.26	0.39	0.72

Table 40. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 5 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	139.7	127.4	101.4	77.2
Soybeans	acres	9.6	9.6	4.8	0
Oats	acres	60.2	54.1	63.6	55.2
Meadow	acres	119.2	137.6	158.9	196.3
Crop production					
Feed grain	bu.	7121	6385	5793	4463
Soybeans	bu.	211	211	106	0
Hay and meadow	tons	189	232	263	304
Permanent pasture	tons	83	83	83	83
Livestock					
Hogs	litters	26	31	22	15
Fat cattle	head	82	108	124	139
Beef cows	head	1	0	0	2
Dairy cows	head	5	0	0	0
Feed fed					
Feed grain	bu.	7121	8839	8618	8549
Protein suppl.	cwt.	249	294	249	210
Forages	tons	251	315	346	387
Costs and returns					
Net farm output	$	17966	18269	17765	16661
Variable costs	$	5317	5721	5496	5505
Net farm income	$	12649	12548	12269	11156
Fixed costs	$	8941	8941	8941	8941
Labor returns	$	3708	3607	3328	2215
Imputed marginal productivities					
Class I cropland	$/acre	48.77	34.03	26.43	17.01
Class II cropland	$/acre	48.04	34.07	29.51	17.01
Class III cropland	$/acre	26.92	18.34	16.52	13.24
Permanent pasture	$/acre	6.86	13.09	13.09	6.79
All land	$/acre	26.80	20.56	18.30	11.85
Hay	$/ton	21.03	15.70	15.70	19.25
Labor (seasonal)	$/hr.	0.37	1.04	1.03	0.82
Labor (annual)	$/hr.	0.11	0.26	0.25	0.26
Capital	$/$ invested	0.06	0.06	0.06	0.06
Quota	$/feed unit	0	0.33	0.51	1.13

Table 41. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 6 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	127.4	112.4	84.5	55.9
Soybeans	acres	34.2	49.2	61.0	37.6
Oats	acres	54.1	54.1	46.1	25.3
Meadow	acres	113.0	113.0	91.0	175.5
Crop production					
Feed grain	bu.	6290	5043	3907	3234
Soybeans	bu.	753	1053	1284	773
Hay and meadow	tons	175	157	129	215
Permanent pasture	tons	83	83	83	83
Livestock					
Hogs	litters	0	0	0	0
Fat cattle	head	62	62	70	68
Beef cows	head	3	6	1	0
Dairy cows	head	0	0	0	0
Feed fed					
Feed grain	bu.	3120	3085	3487	3234
Protein suppl.	cwt.	55	55	59	31
Forages	tons	197	188	188	204
Costs and returns					
Net farm output	$	14076	13347	12879	11201
Variable costs	$	2477	1995	1808	1442
Net farm income	$	11599	11352	11071	9759
Fixed costs	$	8577	8577	8577	8577
Labor returns	$	3022	2775	2494	1182
Imputed marginal productivities					
Class I cropland	$/acre	34.28	19.94	13.77	1.82
Class II cropland	$/acre	24.28	13.49	10.21	1.79
Class III cropland	$/acre	4.87	0.40	0	0
Permanent pasture	$/acre	0	0	0	0
All land	$/acre	10.10	4.81	3.45	0.57
Hay	$/ton	0	0	1.65	2.09
Labor (seasonal)	$/hr.	4.18	4.18	3.38	2.25
Labor (annual)	$/hr.	1.54	1.54	1.39	0.37
Capital	$/$ invested	0.21	0.21	0.21	0.30
Quota	$/feed unit	0	0.34	0.51	1.06

Table 42. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 7 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	30.5	24.9	22.0	15.0
Soybeans	acres	2.1	1.1	0	0
Oats	acres	13.2	15.2	14.1	8.2
Meadow	acres	26.1	30.7	35.8	45.0
Crop production					
Feed grain	bu.	1557	1428	1320	976
Soybeans	bu.	46	24	0	0
Hay and meadow	tons	41	48	54	66
Permanent pasture	tons	18	18	18	18
Livestock					
Hogs	litters	10	6	3	0
Fat cattle	head	14	17	18	17
Beef cows	head	1	0	0	1
Dairy cows	head	1	2	2	3
Feed fed					
Feed grain	bu.	1771	1331	1320	976
Protein suppl.	cwt.	73	51	33	14
Forages	tons	59	66	72	78
Costs and returns					
Net farm output	$	4085	3917	3635	3212
Variable costs	$	917	829	640	587
Net farm income	$	3168	3088	2995	2625
Fixed costs	$	2174	2174	2174	2174
Labor returns	$	994	914	821	451
Imputed marginal productivities					
Class I cropland	$/acre	46.94	22.39	16.38	2.04
Class II cropland	$/acre	44.31	24.15	17.87	3.83
Class III cropland	$/acre	21.84	11.87	8.18	1.31
Permanent pasture	$/acre	4.77	9.26	7.26	0
All land	$/acre	23.37	14.08	10.28	1.59
Hay	$/ton	15.00	11.11	8.72	4.86
Labor (seasonal)	$/hr.	0	0	0	0
Labor (annual)	$/hr.	0.17	0.12	0.13	0.21
Capital	$/$ invested	0.12	0.14	0.19	0.26
Quota	$/feed unit	0	0.60	0.72	1.17

Table 43. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 8 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	98.3	70.2	43.5	31.4
Soybeans	acres	40.7	68.8	81.4	58.8
Oats	acres	22.1	22.1	15.0	15.0
Meadow	acres	38.9	38.9	17.9	15.0
Crop production					
Feed grain	bu.	4897	3374	2340	1809
Soybeans	bu.	841	1384	1628	1188
Hay and meadow	tons	65	58	34	31
Permanent pasture	tons	21	21	21	21
Livestock					
Hogs	litters	5	5	5	5
Fat cattle	head	0	1	2	4
Beef cows	head	0	0	0	0
Dairy cows	head	5	5	5	5
Feed fed					
Feed grain	bu.	709	756	813	916
Protein suppl.	cwt.	43	43	44	45
Forages	tons	34	38	42	48
Costs and returns					
Net farm output	$	9123	8553	7934	6491
Variable costs	$	1777	1412	1175	982
Net farm income	$	7346	7141	6759	5509
Fixed costs	$	6176	6176	6176	6176
Labor returns	$	1170	965	583	-667
Imputed marginal productivities					
Class I cropland	$/acre	38.88	19.60	9.79	0
Class II cropland	$/acre	29.37	15.41	8.13	1.38
Class III cropland	$/acre	8.03	2.84	0	0
Permanent pasture	$/acre	0	0	0	0
All land	$/acre	23.69	11.86	5.74	0.40
Hay	$/ton	0	0	0	1.21
Labor (seasonal)	$/hr.	0	0	0	0
Labor (annual)	$/hr.	0	0	0	0
Capital	$/$ invested	0.47	0.45	0.45	0.43
Quota	$/feed unit	0	0.46	0.72	0.99

Table 44. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation No. 9 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	98.3	84.5	57.9	43.2
Soybeans	acres	40.7	54.5	66.4	30.9
Oats	acres	22.1	22.1	17.1	26.4
Meadow	acres	38.9	38.9	58.6	42.3
Crop production					
Feed grain	bu.	4896	3864	2857	2623
Soybeans	bu.	841	1086	1316	679
Hay and meadow	tons	65	58	76	74
Permanent pasture	tons	21	21	21	21
Livestock					
Hogs	litters	39	29	19	15
Fat cattle	head	8	10	12	17
Beef cows	head	0	0	0	0
Dairy cows	head	0	3	5	5
Feed fed					
Feed grain	bu.	4784	3864	2857	2623
Protein suppl.	cwt.	270	209	142	117
Forages	tons	51	70	85	95
Costs and returns					
Net farm output	$	11162	10464	9679	8030
Variable costs	$	2316	1853	1555	1274
Net farm income	$	8846	8611	8124	6756
Fixed costs	$	6341	6341	6341	6341
Labor returns	$	2505	2270	1783	415
Imputed marginal productivities					
Class I cropland	$/acre	38.88	17.91	3.30	0
Class II cropland	$/acre	29.29	14.14	4.73	0.74
Class III cropland	$/acre	8.00	2.39	0.59	0
Permanent pasture	$/acre	0	0	0	0.70
All land	$/acre	23.65	10.81	2.64	0.30
Hay	$/ton	0	0	3.40	0.84
Labor (seasonal)	$/hr.	0.67	0.40	0	0
Labor (annual)	$/hr.	0.10	0.06	0	0
Capital	$/$invested	0.44	0.44	0.39	0.38
Quota	$/feed unit	0	0.51	0.95	1.13

Table 45. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 10 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	32.4	25.9	22.8	16.3
Soybeans	acres	0	0	0	0
Oats	acres	16.2	17.9	16.9	10.4
Meadow	acres	35.0	39.8	43.9	56.9
Crop production					
Feed grain	bu.	1606	1444	1285	963
Soybeans	bu.	0	0	0	0
Hay and meadow	tons	53	60	70	74
Permanent pasture	tons	73	73	73	73
Livestock					
Hogs	litters	7	4	0	0
Fat cattle	head	10	17	22	14
Beef cows	head	12	8	3	11
Dairy cows	head	5	5	5	5
Feed fed					
Feed grain	bu.	1606	1444	1285	963
Protein suppl.	cwt.	72	49	22	22
Forages	tons	125	122	118	132
Costs and returns					
Net farm output	$	5212	4936	4624	4226
Variable costs	$	1205	1036	852	874
Net farm income	$	4007	3900	3772	3352
Fixed costs	$	3435	3435	3435	3435
Labor returns	$	572	465	337	-83
Imputed marginal productivities					
Class I cropland	$/acre	39.02	18.78	13.30	1.54
Class II cropland	$/acre	41.54	20.29	14.53	2.00
Class III cropland	$/acre	17.61	8.58	6.72	0.06
Permanent pasture	$/acre	0	0	0	0
All land	$/acre	9.02	4.40	3.28	0.24
Hay	$/ton	7.49	7.48	7.48	2.19
Labor (seasonal)	$/hr.	0	0	0	0
Labor (annual)	$/hr.	0	0	0	0
Capital	$/$ invested	0.28	0.28	0.28	0.29
Quota	$/feed unit	0	0.68	0.86	1.39

Table 46. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 11 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	66.4	52.8	48.1	33.2
Soybeans	acres	0	0	0	0
Oats	acres	33.2	36.6	34.7	20.0
Meadow	acres	71.4	81.6	88.2	117.8
Crop production					
Feed grain	bu.	3279	2950	2622	1967
Soybeans	bu.	0	0	0	0
Hay and meadow	tons	109	123	129	146
Permanent pasture	tons	149	149	149	149
Livestock					
Hogs	litters	10	3	0	0
Fat cattle	head	39	50	51	32
Beef cows	head	18	11	12	26
Dairy cows	head	2	1	2	5
Feed fed					
Feed grain	bu.	3278	2950	2622	1967
Protein suppl.	cwt.	103	54	34	40
Forages	tons	225	221	227	261
Costs and returns					
Net farm output	$	9766	9170	8736	8096
Variable costs	$	2012	1646	1507	1673
Net farm income	$	7754	7524	7229	6423
Fixed costs	$	6194	6194	6194	6194
Labor returns	$	1560	1330	1035	229
Imputed marginal productivities					
Class I cropland	$/acre	35.95	14.90	3.99	2.36
Class II cropland	$/acre	38.38	16.27	5.11	2.95
Class III cropland	$/acre	15.37	5.97	1.01	0.28
Permanent pasture	$/acre	0	0	0	0
All land	$/acre	8.12	3.30	0.81	0.40
Hay	$/ton	6.14	6.14	4.03	2.61
Labor (seasonal)	$/hr.	1.53	1.52	1.73	0
Labor (annual)	$/hr.	0.25	0.25	0.28	0
Capital	$/$ invested	0.27	0.27	0.27	0.29
Quota	$/feed unit	0	0.71	1.10	1.35

Table 47. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 12 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	31.2	26.4	21.5	16.7
Soybeans	acres	0	0	0	0
Oats	acres	15.6	16.0	16.5	14.0
Meadow	acres	36.8	41.2	45.6	52.9
Crop production					
Feed grain	bu.	1530	1376	1223	917
Soybeans	bu.	0	0	0	0
Hay and meadow	tons	58	65	71	78
Permanent pasture	tons	73	73	73	73
Livestock					
Hogs	litters	27	15	15	15
Fat cattle	head	4	11	13	11
Beef cows	head	13	12	12	14
Dairy cows	head	5	5	5	5
Feed fed					
Feed grain	bu.	3463	2424	2522	2448
Protein suppl.	cwt.	198	115	116	115
Forages	tons	131	138	144	151
Costs and returns					
Net farm output	$	5946	5593	5537	5215
Variable costs	$	1392	1086	1105	1135
Net farm income	$	4554	4507	4432	4080
Fixed costs	$	3713	3713	3713	3713
Labor returns	$	841	794	719	367
Imputed marginal productivities					
Class I cropland	$/acre	46.93	38.00	20.54	20.54
Class II cropland	$/acre	49.66	41.78	26.85	20.54
Class III cropland	$/acre	28.69	25.01	19.09	16.58
Permanent pasture	$/acre	6.85	6.98	6.98	6.98
All land	$/acre	15.45	13.68	10.47	9.25
Hay	$/ton	21.92	21.39	21.23	21.24
Labor (seasonal)	$/hr.	0.17	0	0	0
Labor (annual)	$/hr.	0.03	0	0	0
Capital	$/$ invested	0.06	0.06	0.06	0.06
Quota	$/feed unit	0	0.32	0.91	1.16

Table 48. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 13 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	64.0	54.3	44.5	34.5
Soybeans	acres	0	0	0	0
Oats	acres	32.0	32.8	33.6	28.6
Meadow	acres	75.0	83.9	92.9	107.9
Crop production					
Feed grain	bu.	3130	2821	2507	1880
Soybeans	bu.	0	0	0	0
Hay and meadow	tons	114	133	145	158
Permanent pasture	tons	149	149	149	149
Livestock					
Hogs	litters	15	22	16	21
Fat cattle	head	36	48	55	47
Beef cows	head	26	25	24	29
Dairy cows	head	3	0	0	1
Feed fed					
Feed grain	bu.	3723	5048	4819	4929
Protein suppl.	cwt.	136	190	161	181
Forages	tons	263	282	294	307
Costs and returns					
Net farm output	$	10581	10811	10584	10028
Variable costs	$	1988	2239	2140	2271
Net farm income	$	8593	8572	8444	7757
Fixed costs	$	6459	6459	6459	6459
Labor returns	$	2134	2113	1985	1298
Imputed marginal productivities					
Class I cropland	$/acre	45.43	41.18	48.54	18.54
Class II cropland	$/acre	48.18	45.04	25.19	18.54
Class III cropland	$/acre	27.13	25.40	17.58	14.93
Permanent pasture	$/acre	6.84	6.86	6.86	6.87
All land	$/acre	14.89	14.11	9.86	8.58
Hay	$/ton	21.32	21.04	21.07	21.07
Labor (seasonal)	$/hr.	0.26	0.37	0.35	0.35
Labor (annual)	$/hr.	0.11	0.12	0.11	0.11
Capital	$/$ invested	0.06	0.06	0.06	0.06
Quota	$/feed unit	0	0.11	0.90	1.16

Table 49. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 14 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	32.4	29.4	25.2	15.4
Soybeans	acres	0	0	0	0
Oats	acres	16.2	14.7	13.4	9.8
Meadow	acres	35.0	30.3	27.5	29.2
Crop production					
Feed grain	bu.	1606	1446	1285	964
Soybeans	bu.	0	0	0	0
Hay and meadow	tons	53	46	41	43
Permanent pasture	tons	73	73	73	73
Livestock					
Hogs	litters	12	11	10	6
Fat cattle	head	0	0	0	0
Beef cows	head	12	13	14	15
Dairy cows	head	5	5	5	5
Feed fed					
Feed grain	bu.	1606	1446	1285	964
Protein suppl.	cwt.	92	82	72	49
Forages	tons	108	117	113	116
Costs and returns					
Net farm output	$	4939	4698	4459	3885
Variable costs	$	1058	966	887	759
Net farm income	$	3881	3732	3572	3126
Fixed costs	$	3435	3435	3435	3435
Labor returns	$	446	297	137	-309
Imputed marginal productivities					
Class I cropland	$/acre	36.24	4.82	4.09	1.85
Class II cropland	$/acre	38.64	5.53	4.76	2.40
Class III cropland	$/acre	13.23	0	0	0
Permanent pasture	$/acre	0	0	0	1.03
All land	$/acre	7.64	0.63	0.54	0.70
Hay	$/ton	0.57	0.55	1.23	2.35
Labor (seasonal)	$/hr.	0	0	0	0
Labor (annual)	$/hr.	0	0	0	0
Capital	$/$ invested	0.30	0.29	0.29	0.26
Quota	$/feed unit	0	1.07	1.11	1.22

Table 50. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 15 with no controls and with 10, 20 and 40 precent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	32.4	29.4	25.2	17.1
Soybeans	acres	0	0	0	0
Oats	acres	16.2	15.2	13.1	9.3
Meadow	acres	35.0	39.0	45.3	57.2
Crop production					
Feed grain	bu.	1606	1445	1284	964
Soybeans	bu.	0	0	0	0
Hay and meadow	tons	53	62	67	74
Permanent pasture	tons	73	73	73	73
Livestock					
Hogs	litters	27	27	27	27
Fat cattle	head	0	0	0	0
Beef cows	head	14	16	17	18
Dairy cows	head	5	5	5	5
Feed fed					
Feed grain	bu.	3264	3223	3247	3422
Protein suppl.	cwt.	192	190	191	192
Forages	tons	126	135	140	147
Costs and returns					
Net farm output	$	5906	5812	5702	5486
Variable costs	$	1410	1416	1435	1471
Net farm income	$	4496	4396	4267	4015
Fixed costs	$	3671	3671	3671	3671
Labor returns	$	825	725	596	344
Imputed marginal productivities					
Class I cropland	$/acre	39.20	17.78	17.78	17.87
Class II cropland	$/acre	41.66	19.54	19.54	19.72
Class III cropland	$/acre	19.25	10.94	10.94	11.16
Permanent pasture	$/acre	8.44	8.54	8.54	8.51
All land	$/acre	12.82	8.40	8.40	8.46
Hay	$/ton	10.14	10.25	10.25	10.48
Labor (seasonal)	$/hr.	1.47	0.99	0.99	0.94
Labor (annual)	$/hr.	0.23	0.15	0.15	0.14
Capital	$/$ invested	0.06	0.06	0.06	0.06
Quota	$/feed unit	0	0.79	0.79	0.79

Table 51. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 16 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	105.6	77.9	71.4	45.7
Soybeans	acres	11.2	38.9	31.0	45.7
Oats	acres	11.2	11.2	16.0	11.0
Meadow	acres	11.2	11.2	20.8	22.5
Crop production					
Feed grain	bu.	6807	5111	4705	2851
Soybeans	bu.	311	901	698	934
Hay and meadow	tons	33.5	33.5	59	56
Permanent pasture	tons	5	5	5	5
Livestock					
Hogs	litters	5	5	5	5
Fat cattle	head	14	12	12	9
Beef cows	head	0	0	0	0
Dairy cows	head	0	0	4	5
Feed fed					
Feed grain	bu.	1581	1635	1696	1333
Protein suppl.	cwt.	63	54	85	56
Forages	tons	22	38.5	64	61
Costs and returns					
Net farm output	$	10151	9629	8780	7360
Variable costs	$	1708	1338	1049	975
Net farm income	$	8443	8291	7731	6385
Fixed costs	$	5613	5613	5613	5613
Labor returns	$	2830	2678	2118	772
Imputed marginal productivities					
Cropland	$/acre	45.25	27.73	16.72	0
Permanent pasture	$/acre	7.28	7.28	5.72	1.07
All land	$/acre	44.97	25.69	14.88	0.07
Hay	$/ton	8.73	8.73	6.87	1.29
Labor (seasonal)	$/hr.	0	0	0	0
Labor (annual)	$/hr.	0	0	0	0
Capital	$/$ invested	0.28	0.28	0.28	0.39
Quota	$/feed unit	0	0.42	0.67	1.04

Table 52. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 17 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	105.6	90.6	76.8	54.8
Soybeans	acres	0	0	0	0
Oats	acres	11.2	16.2	20.8	27.9
Meadow	acres	22.4	32.4	41.6	56.5
Crop production					
Feed grain	bu.	6840	6156	5472	4104
Soybeans	bu.	0	0	0	0
Hay and meadow	tons	68	99	126	168
Permanent pasture	tons	5	5	5	5
Livestock					
Hogs	litters	45	44	42	35
Fat cattle	head	19	31	40	54
Beef cows	head	0	0	0	0
Dairy cows	head	0	0	0	0
Feed fed					
Feed grain	bu.	6278	6898	7106	6733
Protein suppl.	cwt.	327	332	321	277
Forages	tons	73	104	131	173
Costs and returns					
Net farm output	$	12642	12588	12275	11618
Variable costs	$	2616	2692	2690	2638
Net farm income	$	10026	9896	9585	8980
Fixed costs	$	6083	6083	6083	6083
Labor returns	$	3937	3813	3502	2897
Imputed marginal productivities					
Cropland	$/acre	55.28	44.24	41.79	35.56
Permanent pasture	$/acre	17.53	14.45	14.37	13.03
All land	$/acre	49.33	39.00	37.58	31.66
Hay	$/ton	21.03	17.34	17.25	15.63
Labor (seasonal)	$/hr.	3.25	0.76	0.73	1.05
Labor (annual)	$/hr.	0.50	0.13	0.13	0.27
Capital	$/$ invested	0.06	0.06	0.06	0.06
Quota	$/feed unit	0	0.41	0.45	0.58

Table 53. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 18 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	222.1	181.0	123.7	86.1
Soybeans	acres	23.3	64.4	118.1	114.9
Oats	acres	23.3	23.3	25.1	14.4
Meadow	acres	23.3	23.3	25.1	28.8
Crop production					
Feed grain	bu.	14294	11437	8112	5341
Soybeans	bu.	652	1453	2546	2351
Hay and meadow	tons	70	65	70	71
Permanent pasture	tons	10	10	10	10
Livestock					
Hogs	litters	5	5	5	5
Fat cattle	head	20	16	17	19
Beef cows	head	0	0	0	0
Dairy cows	head	0	4	5	5
Feed fed					
Feed grain	bu.	2209	1544	1601	1646
Protein suppl.	cwt.	105	100	103	88
Forages	tons	9	70	77	81
Costs and returns					
Net farm output	$	19956	18829	17432	14031
Variable costs	$	3115	2536	2145	1698
Net farm income	$	16841	16293	15287	12333
Fixed costs	$	10567	10567	10567	10567
Labor returns	$	6274	5726	4720	1766
Imputed marginal productivities					
Cropland	$/acre	37.02	24.32	10.85	0
Permanent pasture	$/acre	0	0	0	0
All land	$/acre	39.72	23.79	9.42	0
Hay	$/ton	0	3.77	3.98	0.99
Labor (seasonal)	$/hr.	0	0	0.04	0
Labor (annual)	$/hr.	0	0	0.01	0
Capital	$/$ invested	0.54	0.43	0.42	0.43
Quota	$/ feed unit	0	0.40	0.76	1.03

Table 54. Profit maximizing farm plans, costs and returns, and imputed resource productivities for farming situation no. 19 with no controls and with 10, 20 and 40 percent reductions in feed concentrate production

	Unit	None	10%	20%	40%
Crop acreages					
Corn	acres	233.6	215.5	151.5	117.6
Soybeans	acres	0	0	29.5	0.9
Oats	acres	29.2	25.5	46.9	57.8
Meadow	acres	29.2	51.0	64.1	115.7
Crop production					
Feed grain	bu.	15233	13710	10832	9104
Soybeans	bu.	0	0	822	37
Hay and meadow	tons	88	146	188	338
Permanent pasture	tons	10	10	10	10
Livestock					
Hogs	litters	18	12	7	0
Fat cattle	head	28	53	67	67
Beef cows	head	2	0	0	27
Dairy cows	head	0	0	0	0
Feed fed					
Feed grain	bu.	4210	4094	4916	4633
Protein suppl.	cwt.	198	203	177	132
Forages	tons	51	156	198	348
Costs and returns					
Net farm output	$	21370	20445	19630	17691
Variable costs	$	3507	2921	2687	2553
Net farm income	$	17863	17524	16943	15138
Fixed costs	$	10730	10730	10730	10730
Labor returns	$	7133	6794	6213	4408
Imputed marginal productivities					
Cropland	$/acre	39.57	25.73	25.02	9.44
Permanent pasture	$/acre	4.50	8.12	7.93	4.71
All land	$/acre	36.28	22.85	22.22	8.50
Hay	$/ton	11.76	9.74	9.51	5.65
Labor (seasonal)	$/hr.	4.79	2.24	2.01	3.79
Labor (annual)	$/hr.	1.89	1.60	1.58	1.81
Capital	$/$ invested	0.06	0.06	0.06	0.06
Quota	$/feed unit	0	0.36	0.38	0.74